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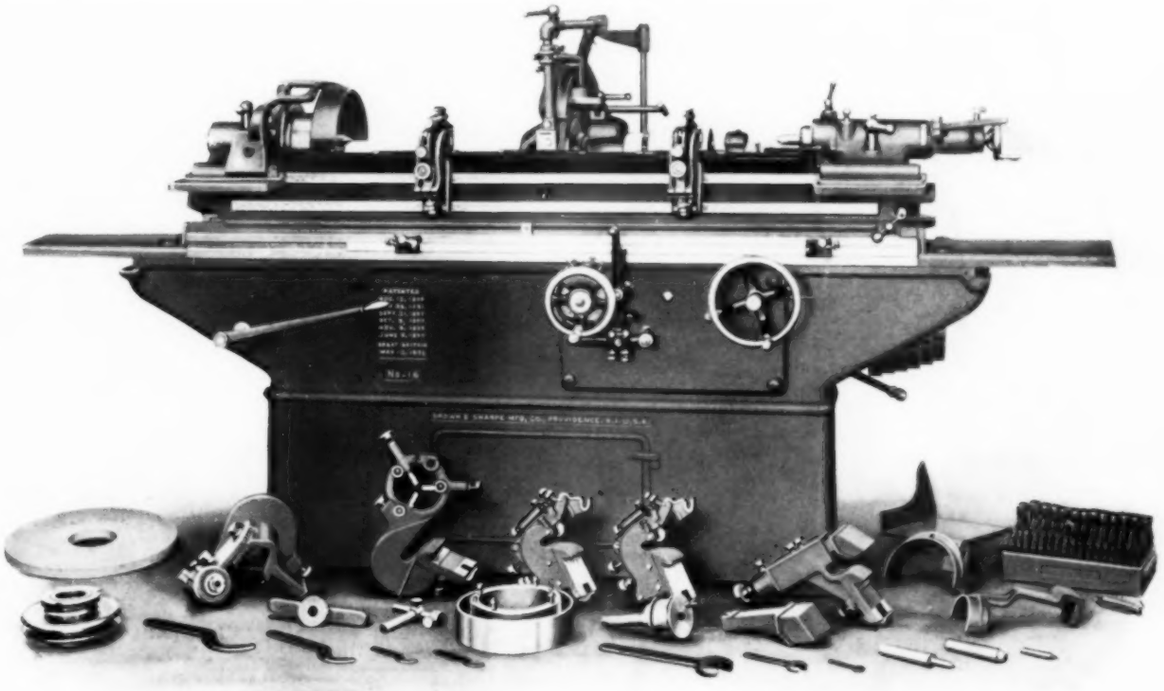

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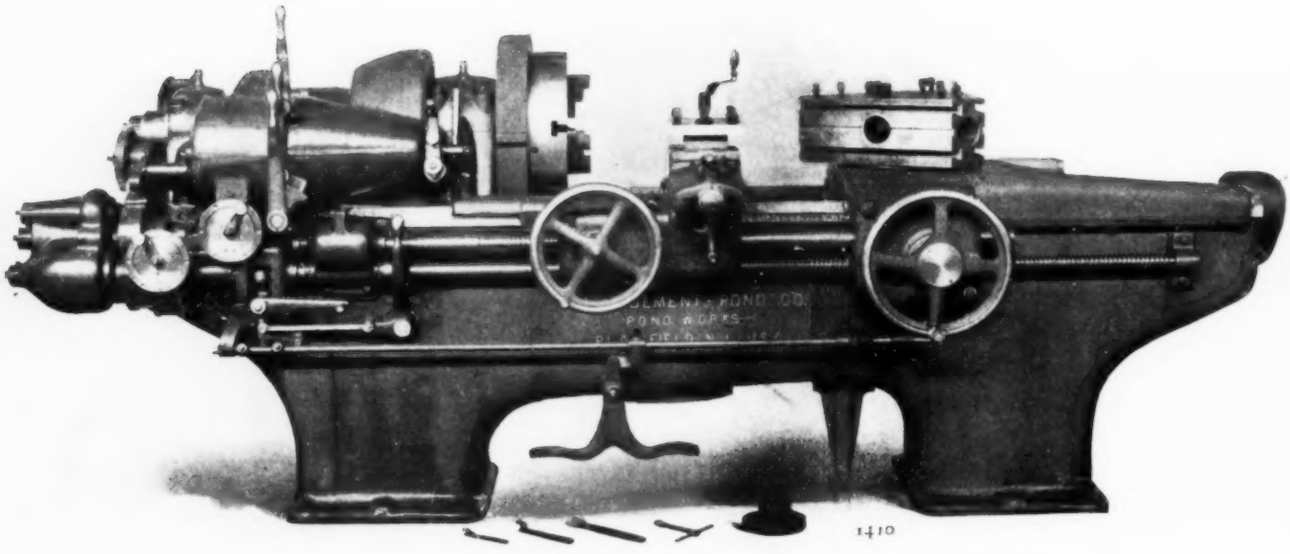

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(*See pages* 51, 52, 53, 54, 55, 56, 57 *and* 58)

Obtaining Accurate Records of Wheel Fits

The New American Hydraulagraph, an Instrument Which Makes It Possible to Know the Exact Pressure Used in Making Force Fits

EDITORIAL CORRESPONDENCE

All who are familiar in any way with the use of the hydraulic press for obtaining force fits realize that in order to secure the best results it is absolutely essential that there be enough difference in the diameters of the parts being fitted to require a sufficient predetermined pressure to force them together. In the case of railroad work, either of the steam trunk lines or the numerous electric railways, it is no exaggeration to say that the safety of the train depends upon a wheel being properly pressed on its axle, and that many bad accidents have been caused by the wheel's fit being so poor as to require only a small pressure to force it into place, resulting in a loose wheel after it has gone into service.

While many wheel and other hydraulic presses are equipped with recording gages, they simply show the maximum pressure which has been used in forcing the parts together, and if the wheel fit happens to be looser than it should be, and the operator is so inclined, it is an easy matter to continue the pressure after the wheel has reached the shoulder, so as to have the record show the desired maximum pressure. Then, too, in most instruments of this kind the records which can be made on one sheet are comparatively few in number and practically necessitate the operator having access to the instrument at all times, which, if he does not fully realize the responsibilities that rest with this work, gives him the opportunity of doctoring the record to suit himself. In some cases he may not be as much to blame as might appear on the surface, as he is paid by the number of wheels that he handles per day, without any allowance being made for the time he would spend in handling a wheel which was not up to standard. There are also too many cases where those in charge of such work are so thoroughly impressed with the desirability of handling a large quantity of work instead of being over particular as to its quality, that they lose sight of the after effects of poor work in such a place.

Realizing the existing conditions in this branch of machine-shop work, the American Steam Gage and Valve Manufacturing Company, Boston, Mass., has developed what is known as the American Hydraulagraph, as shown in the accompanying illustrations, which seems to overcome the existing difficulties in this line by the use of what is practically a continuous steam-engine indicator adapted for hydraulic work. It retains the same general construction as the regular indicator, with a spring capable of recording tons instead of pounds, and securing the motion for the indicator drum from the ram of the press.

The motion of the chart is uniform and positive, between geared rolls, and is not

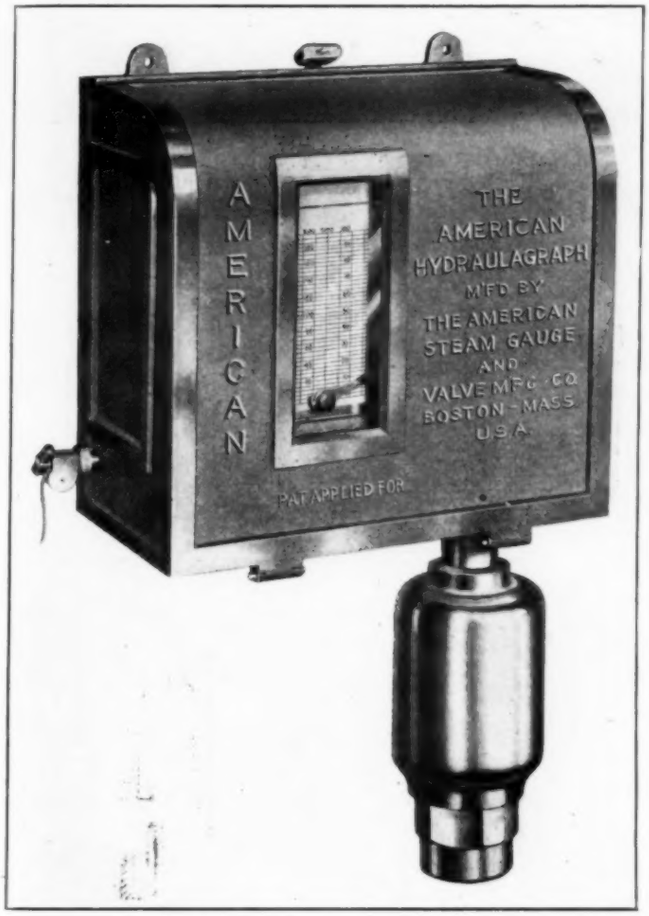


FIG. 1. THE HYDRAULAGRAPH READY FOR USE

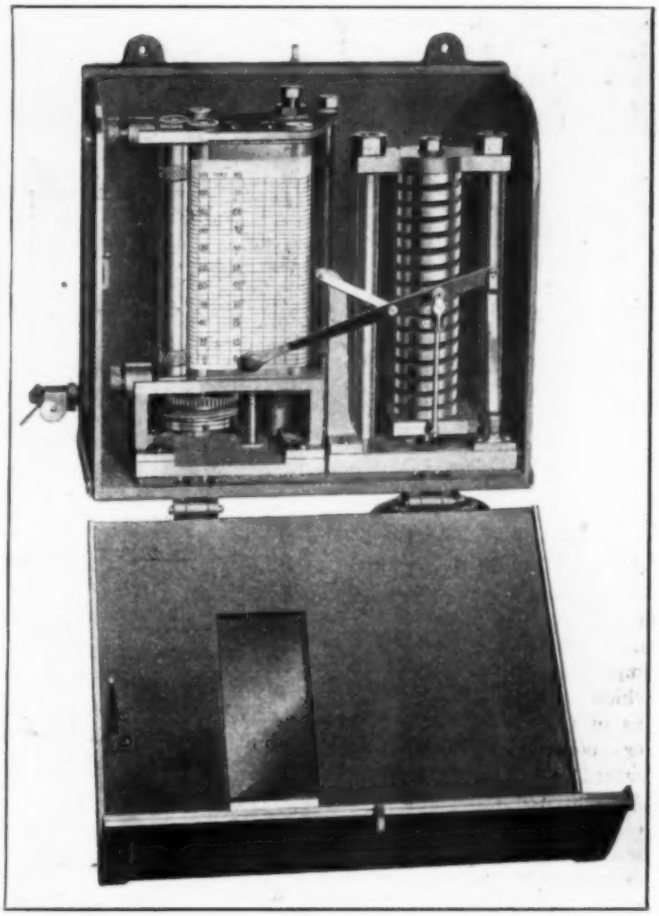


FIG. 2. THE CASE OPEN TO SHOW THE MOVEMENT

affected by the receiving roll, this being quite necessary for a reliable record.

This secures the very desirable results of showing the exact pressure required at each point in the length of the wheel fit, and making it utterly impossible to secure a perfect diagram unless the wheel fit itself is as it should be. By this method the only effect of allowing the wheel to seat on its shoulder is to increase the pressure at that point, while the ram remains stationary. This simply makes a vertical pressure line on the diagram, which indicates at once the manner in which it was obtained. In this instrument there is no necessity for the operator having access to the case as it carries a roll of paper 100 feet long, which is enough to last a week or more in most cases, as each roll holds diagrams for from 200 to 240 pairs of wheels. The opening in front above the glass allows him to write the number of the wheel being pressed at the top of the diagram, as can be seen in those shown in Fig. 4. It also allows him to see just what he is doing. It is, however, impossible to doctor records with this instrument in any case, as unless the ram and pencil move together, a straight line is the only result and this shows at once that something is wrong.

Referring to the details of the instrument shown in Fig. 3, the general construction becomes apparent, and the mechanism for moving the paper under the recording pen is clearly shown.

To prevent sudden shock on the instrument, as in the case of a poor fit suddenly coming against the shoulder, or in removing old wheels, the protecting chamber shown in section below the instrument itself has been provided. Pressure comes in from below and raises the small check valve, which is prevented from lifting too high by the projection on the end of the indicator piston. The annular chamber is filled with air, which is compressed by the liquid and acts as a cushion in preventing sudden shock. The area of the piston is that shown in the upper portion with the two grooves, the enlarged end at the bottom acting as a sort of dashpot as the liquid flows around the enlargement in one direction or the other. In case of a sudden release of pressure, the check valve closes and prevents extreme shock in the other direction. This check valve has a small groove on opposite sides of the seat, running around the head and down the full length of the shank. This allows a gradual release of the pressure so that the pen returns easily to its zero position.

When the maximum pressure is reached the valve on the stem seats and protects the spring and recording mechanism, no matter how much excess pressure may be exerted by the pump. This also does away with a stop cock, making it impossible to avoid recording every fit made.

In Fig. 4 are shown a number of diagrams which, with the comment above, explain themselves. Each vertical line represents one-inch travel of the ram, while the tons of pressure are indicated by the horizontal lines, each line indicating either 2½ or 5 tons, according to the spring being used in the indicator. The diagrams are marked so that they can be used with springs of either capacity. The number above each diagram indicates the number of the wheel being operated on.

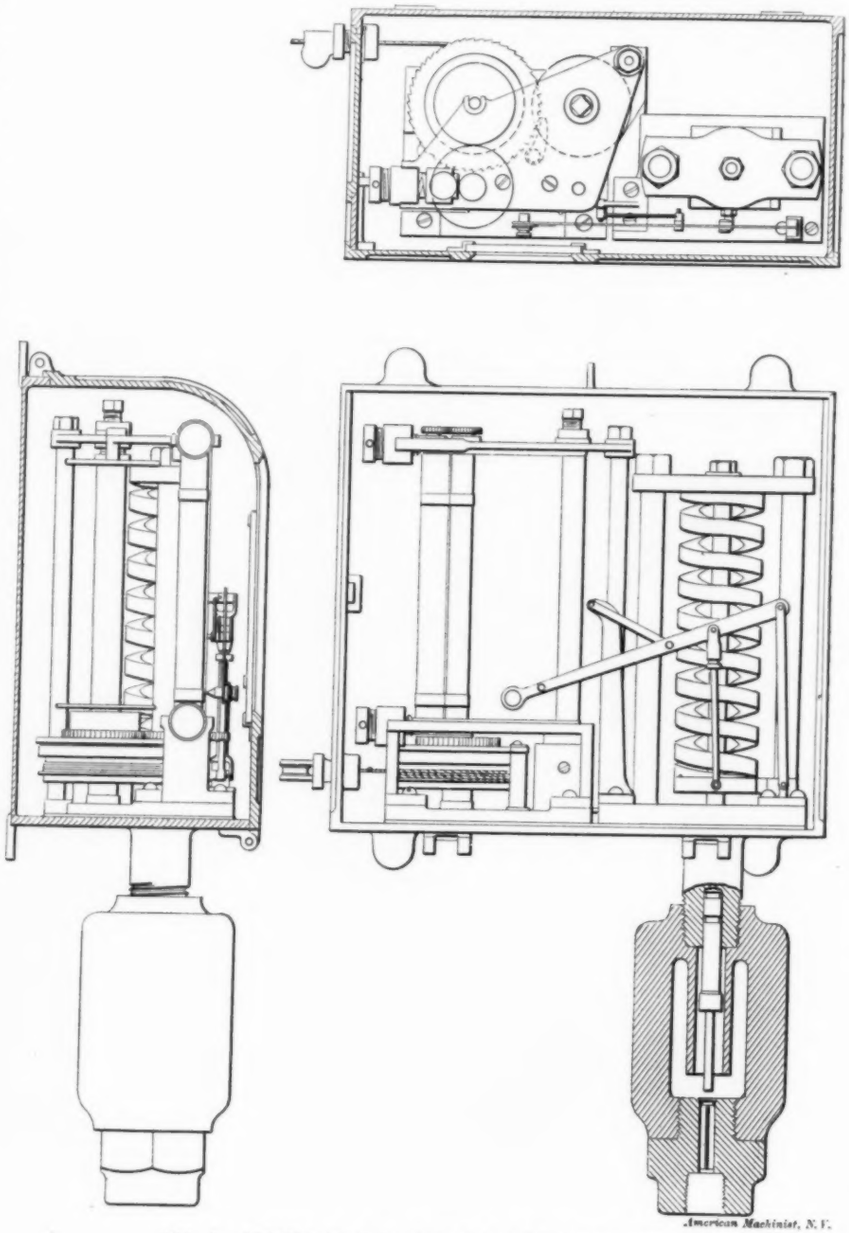


FIG. 3. DETAILS OF THE AMERICAN HYDRAULAGRAPH

In the diagrams shown by pair No. 7, the pressure required to remove wheels from axles is given, and while these are not usually taken, they form an interesting record. They show the high pressure taken to start the wheel, the sudden reduction after it starts and the apparent catching or seizing before it finally decides to let go gracefully.

The last pair show very peculiar results, and when we consider that fits of this kind can very readily be turned out with the usual method of using hydraulic presses, either with or without recording gages, we are inclined to wonder why there are not more accidents from poor wheel fits. The fact that there are so few is the best indication we know of that the great majority of workmen can be depended on to do honest work, and that the percentage of dangerously poor fits which go out of the shop is very small indeed. But one accident will cost many times the amount represented by these instruments and it is the worst kind of economy to take chances of the kind. These diagrams, however, make the best kind of evidence in case of accidents, and it would be extremely difficult to convince any jury that a derailment was caused by a loose wheel, after they were made to understand the significance of such a

record as this, and could be shown that the wheel in question made a good diagram in being forced into place.

In addition to its commercial side, this instrument is a distinct addition to the mechanical world as a means of obtaining accurate knowledge, as it will enable the securing of data regarding press fits, which it does not seem possible to secure in any other way. One or more of these instruments in a shop having a large variety of this kind of work will give invaluable records, some of which we expect to publish at a later date.

Wheel makers should also be especially interested in the use of an exact recording instrument as they have doubtless replaced many wheels as defective, which were burst from over pressure. In fact, with the usual gage and its violently vibrating pointer, it is difficult to know what pressure is being used.

"Made in Germany"

By J. Richards

Forty years ago we had the laugh on Germany, so to speak. England had no technical schools, we had in this country only a few and Germany had many. The "x, y, z" people with a pair of spectacles, who could not drive a nail, were a source of continual amusement to what we then called the "practical" world. The attempts in north Europe to found skilled industries by means of laboratories and books was laughed at and, indeed, were a failure, as many attempts in the Rhine and Saxon cities proved. They knew how things should be done, but had no one to do them, and "made in Germany" became a synonym of bad quality. We all remember this, but now the tables are turned. The shoe is on the other foot, so to speak, and we have Professor Sweet saying: "I do not know if we make the most accurate work of any engine-maker in the country, but one thing I do know is we make them as well as we know how; but not as well as the same engines are made in Germany."

The professor made this remark some time ago, when he had been examining the work in Germany and no doubt has brought his own practice up abreast with his German friends.

England has now many technical schools. So have we. The Scandinavians have their slöjd schools and Russia is well provided; but Germany is long ahead, because earliest in the race. The slöjd boys have learned handicraft, grown up and most of the earlier ones are gray-headed; also the abortive attempts are over. The Rhine is lined with chimneys from Mannheim to Cologne and is a canal. I had difficulty a few years ago in finding my way about the city, which had been familiar 14 years before, and on inquiry found the population had an increment of 150,000 in that time. Mannheim, Coblenz and others the same, and across from Mannheim a new city, Ludwigshaven, had grown up, with great factories —one employing 5000 people in the chemical industries.

There are five of these chemical works in Germany, that employ an aggregate force of 20,000 men and send to this country alone $14,000,000 worth of chemicals made from materials from here mainly, that go across the Atlantic and are towed in barges up the Rhine. Aniline dyes form a large part and these are distributed elsewhere all over the world.

Sulzer Bros., of Winterthur, Switzerland, had 1200 men and other works, such as the Oerlikon and Escher, Wyss & Co., of Zurich, Brown, Bouviere, of Baden (Swiss), have branches in Germany and thereby have exerted in Germany a wide influence in shop manipulation.

In machine processes and in fitting, the early and fine work of the Swiss people is known, and as their works are mainly on the German side of Switzerland, or on the Swiss side of Germany, one can easily see the result of the flow of population from one country to the other, when all spoke the same language and had a common object in view.

Here is the highest attainment of shop morale and skill I have ever met with and many things that we of this newer country can observe with advantage. Not in productive power, although that is good. The whole is a result of a combination, Swiss and German, the best of both, surrounded by old social conditions and homogeneity of race which this continent cannot at the present time furnish.

Looking for a Bossing Job

By W. Osborne

"Mr. Jones, I want to go to work for you."

"Why, Tom! How is this? I thought you were working at the other shops. I am sure that I can't give you as good a job as the one you had there. I have understood that you were on the best work in the shop and having good success with it."

Tom shook his head with a defiant gesture. "The job was good enough as far as that went; but when a firm tries to rub it in on me I won't stand for it, that is just all there is about that."

"I believe in a man standing up for principle too, Tom, but I always supposed they used their men well. What is the matter anyhow?"

"Now I will just tell you what the mat-

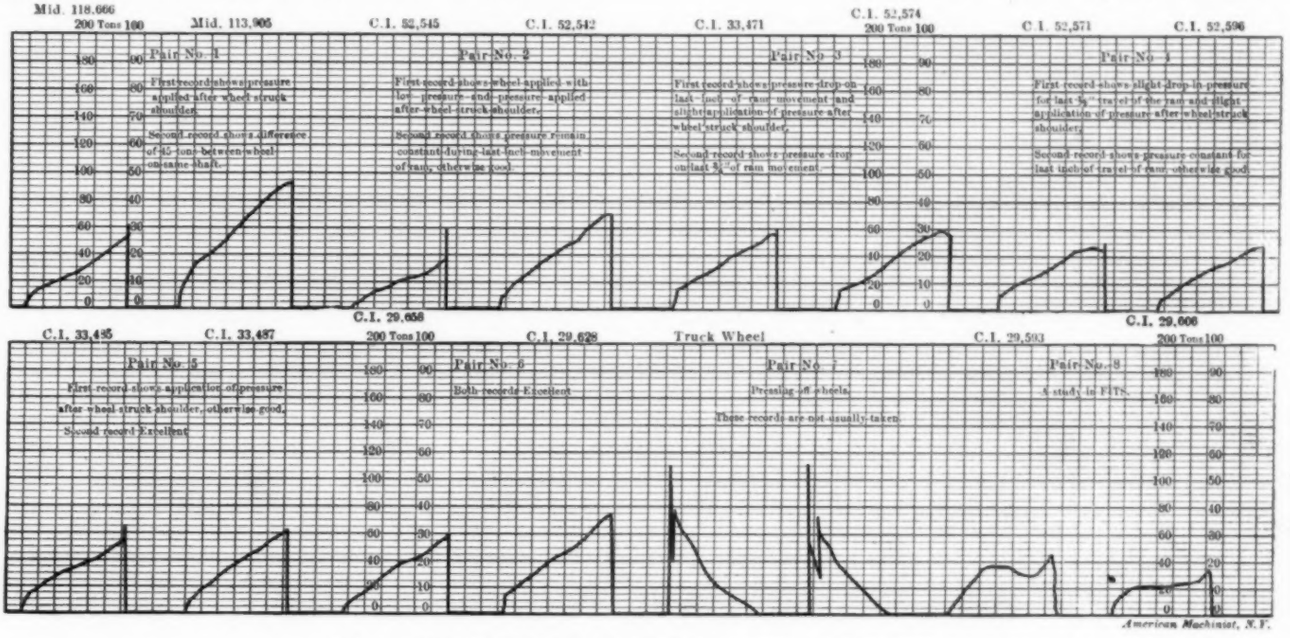


FIG. 4. SOME OF THE RECORDS OBTAINED OF GOOD AND BAD FITS

ter is. Their foreman has quit, and by everything that is fair I ought to have had his place and instead of that they have put in that young Thompson that don't know as much as I've forgot. He has only worked for them about a year and I have slaved along for them for more than six. I didn't mind it the other time when they put in Frazier. He was a foundry foreman who was out of a job, and now he is out again, and he was a nice man. He didn't want a man to kill himself trying to make the company rich, and it wasn't looked on as an unpardonable sin for a man to have a little smoke at his work so long as the old man did not catch him at it. Frazier liked a smoke himself and knew the fellows who carried the best tobacco.

"This Thompson is one of these fellows that don't know anything but work. He is too good to go out with the boys and share their fun, but he is everlastingly asking some sort of foolish question that no one but a college professor cares anything about. If they had put in any other fellow I would not have minded it so much. I told them I wanted the job, and that it was my turn for I was the oldest man in the shop. When they went right ahead and put him in I quit. If a man won't stand up for his own rights he isn't good for much."

"It does seem rather hard for a man to find that after he has gone to the trouble of preparing himself for advancement and an opportunity comes he is not given the chance; but never mind, there are other places where foremen are needed."

"I have just been thinking about that very thing myself. Just give me a letter to help me on and I will make a try at it."

This was a new turn the matter was taking. I was willing to help any man that I could, but I was very careful about recommending anyone unless I felt reasonably certain that he was competent to fill the place that he wished. I knew this man to be a good molder because of his having held a job of that kind for years in good shops, but I had yet to find out about his fitness for running a shop. I would have to do a little investigating before I would care to give him a letter recommending him for such a position. "I suppose you know all about the mixing of irons so as to get the proper results," I remarked as a feeler.

"Oh, yes, I've taken off a heat when Frazier was away. We used two pieces of pig from the pile in the corner to one from the pile by the fence, and put in fifty pounds of scrap for every hundred pounds of pig."

"Where did that bring your silicon?" I asked.

"I really never heard. I am not sure that they ever used any silicon over there. They did have some limestone once but I don't remember ever seeing any silicon. They might have had it though and I didn't see it, for I wasn't very much of a hand to go prowling around and poking my nose into things that wasn't part of my business. If I was boss I would use anything they got and wanted me to use, though, if they told me to."

"How much coke would you use?"

"There is one place where I would watch things. I would see that the fellow that looked after the cupola used enough to bring down the iron good and hot. I don't like to hang around myself waiting for the iron when I might as well be on my way home. I believe in getting the wind on early and letting the boys get away early. It gives them a chance to have some fun in the evening. If a fellow hadn't anything to do but to sit around and read after supper it wouldn't matter, but a real live fellow like me has."

"About where do you think your melting ratio would be?"

"I would let the office figure out that if they wanted to know. If the foundry gets out castings it can't be expected to do the work of the office too. The office buys all the stuff that the foundry has to use, and I can make the molds and melt up whatever they furnish and put into them."

"How much would you think it safe to lift on a half-inch chain?"

"It'll hold a pretty big flask. I can't say off hand how much it would carry."

"How much would a flask six feet by four feet by three and a half feet weigh when it is full of sand if the flask weighs 1275 pounds?" was my next question.

"I guess I would have to look it up to be able to answer those sorts of questions. They sound like some that Thompson used to be everlastingly poking at the boys," he added with a laugh.

"What books do you have on foundry practice, and which of them do you think the best?"

"I'm not one of those fellows who runs to a book for everything. I worked for a fellow once who wrote one of them foundry books and there used to be lots of bad castings made. He used to be trying all sorts of fool things. He must have cost the company a heap, but they seemed to think anything he did was all right. You can bet if it had been a common fellow like me they would have sung a different song, but just because he wrote a book and was always writing something for the papers they let him do as he pleased." (As a great deal of our most advanced foundry practice has been made possible by the work of that same man, both as an investigator and as a writer able and willing to give the results of his efforts to the public, perhaps they did well.)

"Even if you don't have very many books I suppose, of course, you take your trade paper and so keep in touch with what is going on in the trade outside of the shop you happen to be working in?" I knew that very few who were in positions of responsibility got along without that kind of help.

"Thompson tried to get me to sign for a paper so that he could get a rake off. I did look a few over just to please him, but they wasn't any good. Some of it was just figures, figures till you couldn't rest, and the rest of it was just pictures of machines or else telling about work just like we have here in the shop. I learned my trade and can do my work without having to read what some boy writes about it."

"I have no doubt that you are a good molder and learned the trade well when you did learn it, but now you want me to recommend you for the position of foreman. A man to be a good foreman has to be something more than a good workman and as far as I can find out you have not even started in to begin to learn the trade of foreman. You might get along in some place where all the foreman had to do was to see that the men made their molds properly, but even then I am afraid you would be helpless if anything new came along. Thompson came over here one day and asked me to let him canvass the shop during noon hour for subscribers for some trade papers, and I felt that he was doing me a favor by coming. He used to often come over to see how we did work, and I was glad to let him do it, for he was always full of ideas and I felt that he did the shop as much good as it did him. When Frazier was let out I told them that they had the making of a very good man right there with them, and they were bright enough to see it and put in Thompson, and I think they did well. They talked of you and said you were a good molder and nothing else. It was not their fault that you did not get the job but your own. Supposing you had a foundry building and were put in charge and had to select and order your own supply of irons, coke, sand and supplies, and hire your own men and instruct them as to how you wanted to have things done. Suppose also that you had to make castings to specifications furnished to you and to guarantee results. Supposing that you had to bear the cost of any mistakes that you made, would you tackle the job? And if you would not, have you any right to hunt for that kind of a job and expect some one else to stand it while you blunder and flounder and get them into trouble?

"This may seem rather plain, but I am a friend of yours and want to see you get along, and my advice to you is to go back and go to work for Thompson and see if you can't be ready, when some bigger shop wants him, to step into his place."

Mr. Jones says that it is not of much use to talk "turkey" to some people, for Tom is still a molder, and is not half as friendly as he used to be.

Perhaps he thinks that Mr. Jones belongs in a class along with the college professors and Thompson.

The Machines That Make Cordage

Some Mechanical Combers and "Twisters" Now Replacing Old Rope Walk and Hand Process of Transforming Fiber into Twine and Rope

EDITORIAL CORRESPONDENCE

The expression, "Done by a twist of the wrist," would very fairly describe the method of manufacturing rope, even a very few years ago. At the present time there are still a few relics of the once familiar, long, low building, known as the ropewalk, but these are growing fewer and fewer and practically all of the rope commercially manufactured in this country is now made by automatic machinery.

What is known as hemp rope is made principally of two vegetable fibers; manila, which, as is well known, is the most important product of our Philippine possessions, and sisal, which comes from Yucatan in Mexico. The manila fiber really makes very much the better rope, and sisal rope is used only where strength and durability are not the leading requirements.

The Manila

Manila plants are not greatly different from banana plants and are of the same botanical family. The leaves grow up from the ground in a close bunch, giving the appearance of an ordinary tree trunk; but at a hight of about 12 feet from the ground, these branch out into long, somewhat palm-like leaves as is often seen in characteristic photographs of tropical vegetation. The manila fiber comes from the portion of the leaf which grows along the trunk of the tree.

Not far from the ground the leaves are cut off and separated from the other stalks forming the trunk, and after the upper portions of the leaves have been removed, the stalks are cut longitudinally into strips. Next the pulp is removed from the fiber by drawing these strips between a dull knife blade and a hard-wood block. This operation of drawing the fiber to remove the pulp is said to be very laborious, but up to the present time, no satisfactory machine has been developed to do this work mechanically. The native grasps the fiber which he draws through the scraping device and coiling it around his arm is able to hold it firmly and draw it through, a short length at a time, continuing to wrap the drawn fiber around his arm and to take a new grip as the fiber comes through.

Several attempts have been made to design machinery to do this, but any mechanical gripping device greatly injures the fiber and there does not seem to be any method of holding it as good as that of the native who wraps it around his arm and grips it with his hand. The fiber is next dried in the sun and it is then sorted into different grades and pressed into bales for shipping to this and other countries where it is made into rope, the better grades generally coming to the United States.

The Sisal

Sisal fiber comes from Mexico, as said. The sisal plant is very similar to the ordinary century plant in appearance, but it is in only certain parts of Mexico where fiber suitable for the making of rope from this plant will grow. The growing of the sisal is a large industry and there are many broad plantations in Mexico devoted to its cultivation. The leaves or spines when cut off are about four feet long and have the shape of sharpened wooden stakes.

These leaves, which are known as pencas, are run through a machine which removes the pulp, leaving the fiber. The action of this machine is simply that of a series of scraping knives on the periphery of a revolving wheel. The knives are dull-edged and scrape along the length of the leaves against a curved metal plate following the periphery of

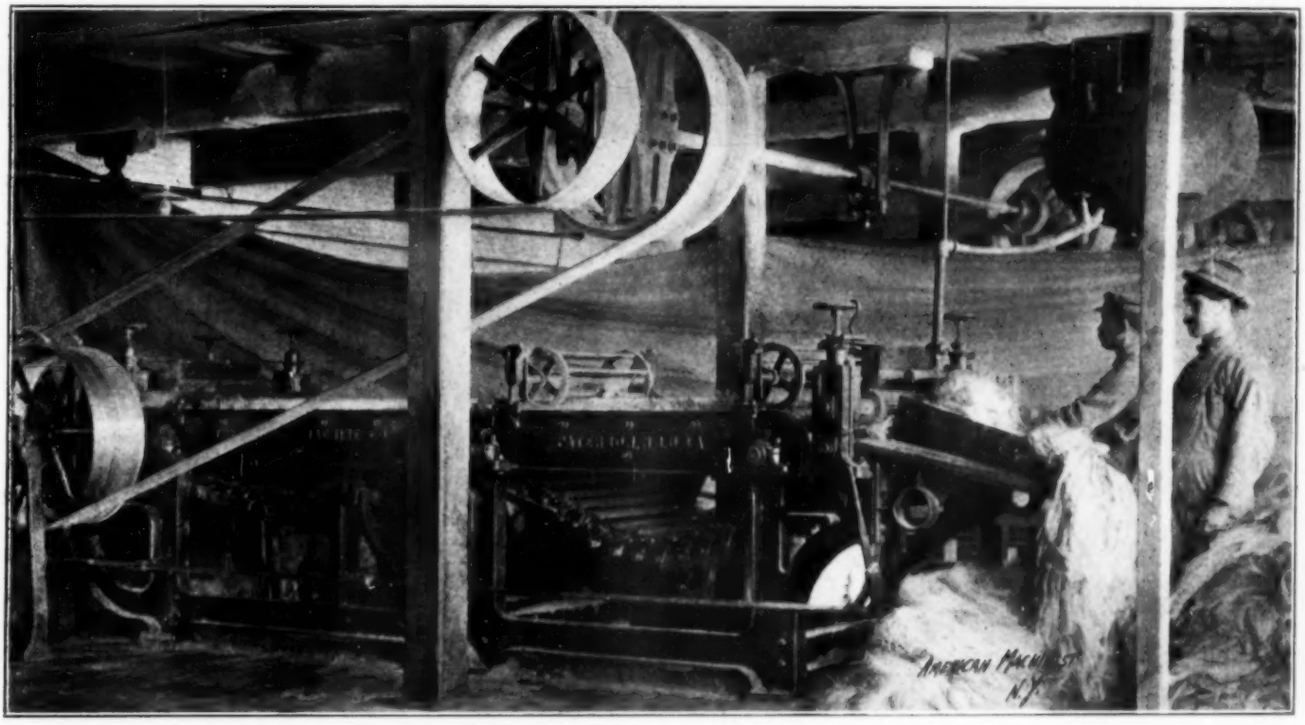


FIG. 1. THE BREAKER OR COMBING MACHINE, SHOWING OIL SPRAYER

the wheel. This quite effectively removes the pulp and the long fibers are carried out by a chain belt and then after being sun-dried are packed into bales.

Hand Methods

It is probable that the old method of making rope by hand did not change very much from the times when the Egyptians used rope to lift the stones to build the pyramids. There are many records in ancient history where ropes were used, so that rope itself is anything but a modern invention. It is only the adaptation of automatic machinery to the production of rope which is at all modern.

FIG. 2. A SISAL PLANTATION IN MEXICO

In the old days the ropemaker wound a bunch of hemp around his body and fastening part of it to a hook in the wall he walked slowly backward while he drew out from the bunch around his body small portions of hemp which he added to that fastened to the hook and twisted it round and round with his fingers, the hook holding the hemp being turned by another person. As he added more material he continued to twist and to back and in that way eventually produced cord or yarn of the hempen fiber. This yarn was afterward twisted into strands and then into ropes having three or four strands, and as times progressed, more and more mechanical devices, though of crude form, were produced to assist the hand laborer in the work of laying and twisting the rope so as to produce a better product and at the same time do it more quickly.

The underlying principle in rope making, which is fairly well known, is that each individual strand making up the rope has a certain twist given to it within itself, and the combined twist of these strands reacting against each other frictionally causes the whole rope to stay in a naturally twisted condition. The illustrations accompanying this article show several of the machines which are used in the manufacture of rope.

"A Twister"

Fig. 8 is a diagram of a very crude rope-making machine, and perhaps it should be said in justice to modern rope manufacturers that no such machine as this is in use in any of the factories. However, it very simply illustrates the principle upon which rope is laid or twisted into shape. In this illustration it will be seen that a triangular frame has projecting through each of its three corners a hook, which at the back of the frame is bent into the shape of a crank. Each of these cranks projects through one arm of a three-armed frame, and in the center of this three-armed frame there is a handle by means of which this three-armed frame may be caused to describe a circle so that each one of the hooks and cranks may be made to revolve on its own axis, all revolving at the same speed. It must, of course, be understood that the triangular frame which supports the axes of the three hooks does not itself revolve, but that each hook revolves only on its own center by the action of the cranks and the three-armed frame back of the triangular frame.

As shown, each of the three hooks carries one strand of a three-strand rope, this rope being fastened to a swivel hook at the other end of the illustration. This swivel hook is entirely free to turn on its own axis as the rope twists. Starting out with three strands passing from the three hooks directly to the swivel hook at the other end, it will be understood that as the three-armed frame with its handle is moved, causing the three hooks to revolve, each one of the three strands is twisted on its own axis. It will be found that as the twisting continues the three strands have a very strong tendency to wind about each other and at the same time the far end of these strands will begin to turn in the same direction as the rotation of each one of the hooks. These various rotations and motions are indicated by the arrows in the illustration.

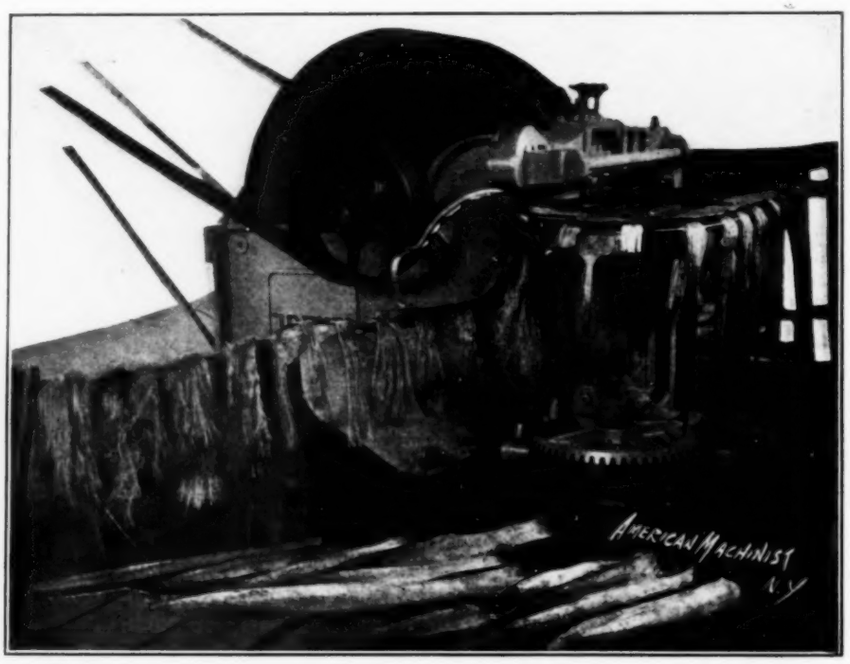


FIG. 3. SISAL MACHINE REMOVING PULP FROM THE FIBERS. PRIETO MACHINE COMPANY, NEW YORK CITY

As the motion of twisting the hooks continues, the twisting of the strands and their tendency to wind about each other and to rotate the swivel hook at the far end produces a genuine rope, which,

FIG. 4. FEEDING THE FIBERS INTO THE SPREADER

if cut off at any point in its length, will remain in its twisted condition just like any good first-class rope. As a matter of fact, in order to get the correct tension on all parts of the rope thus formed, the swivel hook at the far end of this crude device would be provided with a wheel by which another operator would assist the rope in twisting upon itself, because the friction of the parts would have a tendency to prevent the rope from twisting up as tightly or as evenly as it naturally would. This, then, is the principle underlying the making of rope, and it is the individual twist given to each strand which makes the rope have its tendency to remain in a twisted condition.

As may be surmised, the twisting up of the strands and the formation of the rope, illustrated in Fig. 8, will cause the rope to grow shorter and shorter, and in the old-fashioned ropewalks where a modification of this device was used not so very long ago, a track was provided by which the twisting mechanism could travel along the ropewalk as the rope became more and more twisted, and consequently shorter and shorter. Suitable means were provided for keeping a uniform tension on the rope as it was formed, and in this way a very good quality of rope was made, although the process was necessarily slow and the output probably not so uniform as modern machine-made rope.

Before the three strands are twisted into the finished rope it is, of course, necessary to make the strands, and each of these individual strands is made up by twisting together a number of smaller strands known as yarns. These yarns are made from the manila and sisal in spinning machines which draw out and twist the fibers into the shape of a yarn which is wound on a bobbin by the machine. Before the fibers coming from the Philippines and from Mexico can be twisted into yarn, there is some little preparation necessary.

Combing Out the Fiber

Manila fiber has first to pass through a softening machine. This machine is simply a series of from six to ten heavy fluted rollers, and as the manila hemp passes through these rollers, oil of a certain kind is sprinkled over the material to soften it. After this an attendant

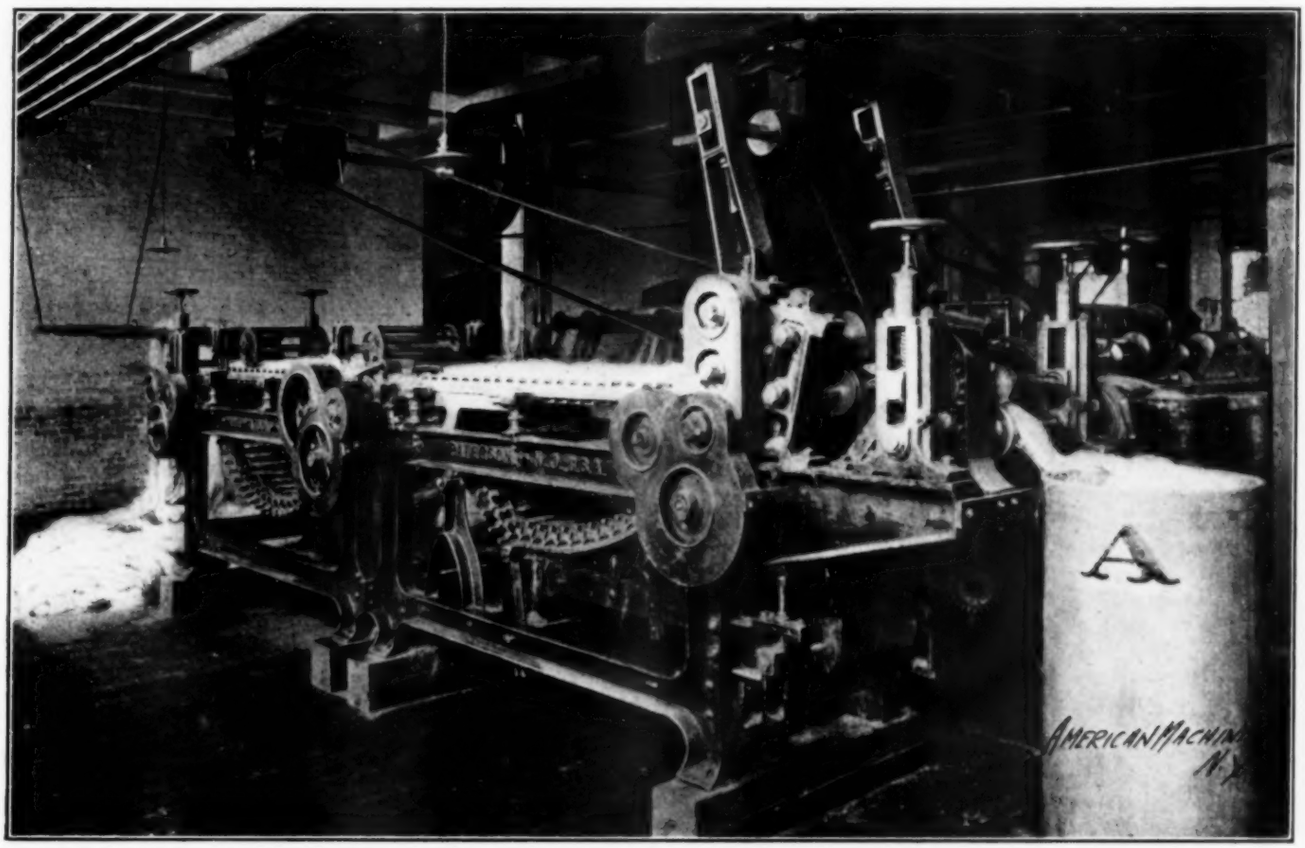


FIG. 5. SEPARATING AND FINISHING MACHINE

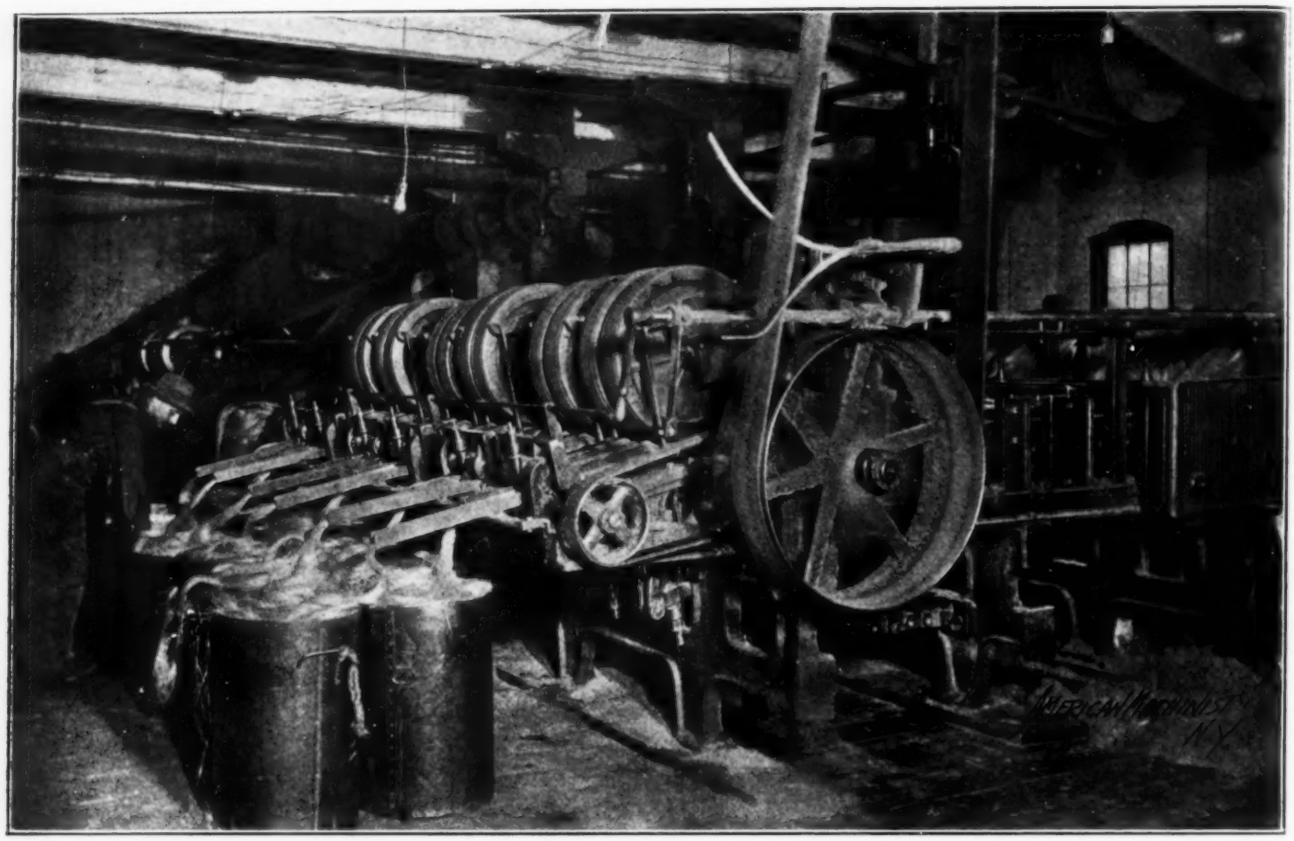


FIG. 6. ANOTHER FORM OF FINISHER. THE FIBERS READY FOR SPINNING

grabs a bunch of the fibers and gives them a rough combing out by throwing the end of the bunch over a revolving wheel carrying a large number of steel points in its periphery, the bunch of fibers being grasped in the middle by the operator.

After thus being roughly straightened out, the fiber is fed to what is known as the breaker. This machine consists mainly

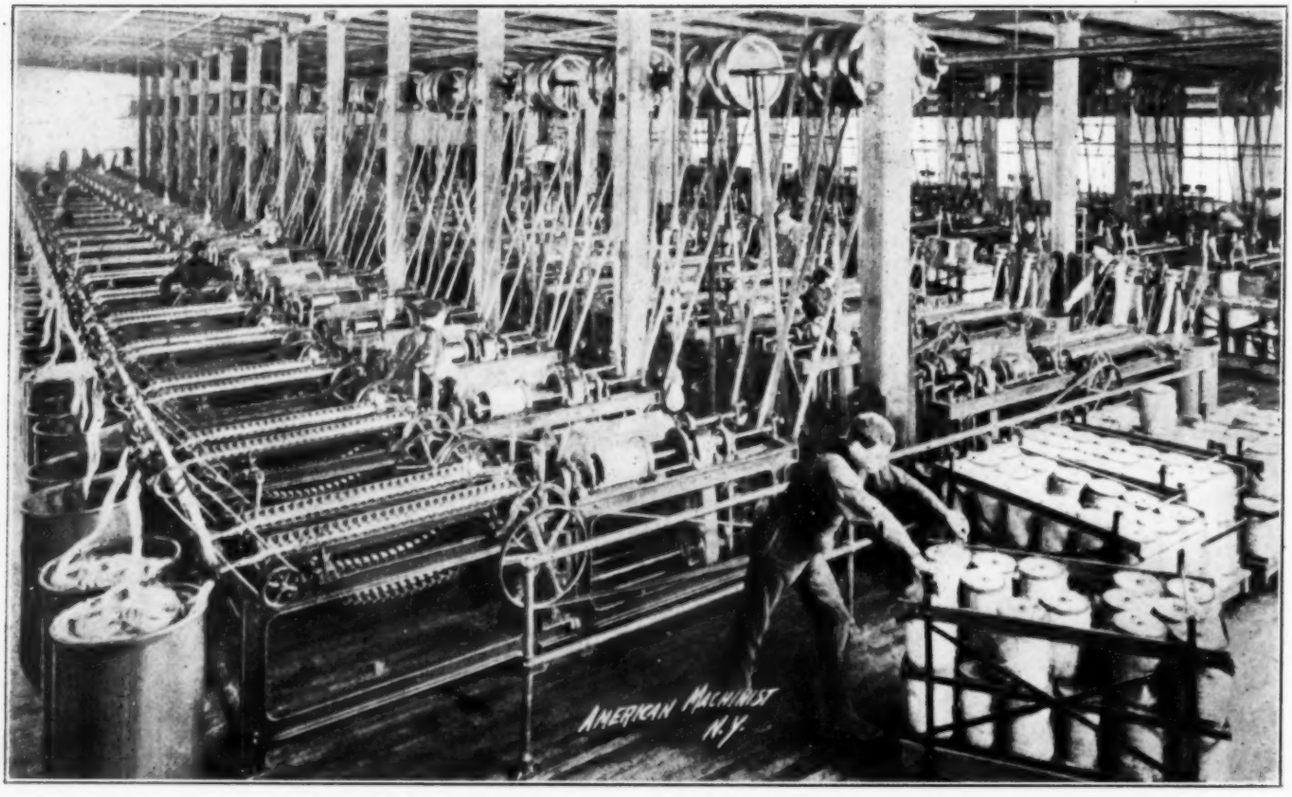


FIG. 7. A SPINNING ROOM. MAKING THE YARNS

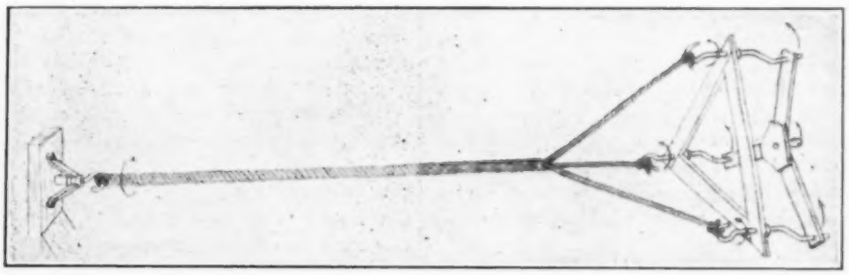


FIG. 8. THE PRINCIPLE OF ROPE MAKING

of two endless traveling chains placed in series with each other. In these chains a very large number of steel pins are fastened, giving an appearance not greatly different from an immense curry-comb. The second chain in the series travels from six to ten times as fast as the first chain, and as the manila fiber is fed first to the slow chain and is carried forward by its motion, the material is delivered to the second chain traveling at the higher speed. These two different speeds of the two chains in series draw out the fibers, tending to make them straighter and straighter, and, of course, at the higher speed tending to diminish the number of fibers in a given cross-section drawing them out into a long stream known as a sliver.

Slivers from several machines are brought together and passed into still another machine, and so on, the machines becoming of lighter and lighter construction, and drawing the fiber out straighter and straighter and longer and longer.

Manila hemp will be worked on from four to six of these double-chain breakers and similar but lighter machines called spreaders, and sisal will require from five to eight workings. After this number of combings on the double-chain machines, the fibers pass to what are known as the drawing frames. These drawing frames are almost identical with the breakers and spreaders except that they are much lighter in construction and also that they are provided with only a single chain instead of two in series traveling at different speeds. The drawing frames are, however, provided with fluted rollers at the end and these rollers travel at a speed of from four to six times that of the chain, thus further drawing and combing out the fibers and preparing them for spinning into the yarn.

From the drawing frame the fibers progress to the finishers, which differ from the drawing frames mainly in the fact that instead of the fluted rollers at the end, there are two revolving leather belts, as shown in Fig. 5. These belts travel on rollers so situated relative to each other that the belts press against each other in a loop during a part of their travel and the sliver delivered by the chain belt just back of the leather belt is passed between the two leather belts just at the point where this loop commences. The sliver is then carried in and up and over several rollers, the action of the rollers and belts being to press the fibers closely together. After making this circuitous course between the two leather belts, the sliver is delivered to two iron rollers which further compact the material so that it passes out in a narrow continuous stream. The slivers are delivered into metallic cans where the fibers naturally coil round and round in neat figures without becoming tangled among themselves.

There are also other machines as shown in Fig. 6 which combine the traveling chain comb and heavily weighted rollers which finish the sliver ready for the spinning jennies.

Spinning Yarns

The next operation is to twist these slivers into the yarn on the spinning jennies. The degree of twist given to the material at any time during its progress is very important, because each individual yarn has its own twist and these again are twisted into the strands which in turn, each having its own particular twist, are again twisted into the final rope. Manila fiber is very strong in a lengthwise direction, but is quite brittle in a transverse direction. If then, a rope could be made up of manila fiber as long as the rope itself, it would be stronger if it were not twisted; but as each fiber is comparatively short, the yarns and strands, and consequently the whole rope, are held together simply by the friction of the different fibers upon each other due to the degrees of twist pressing the different fibers against each other. The greater the twist the greater the friction between the parts, but as said, the more twist the less strength there is in each individual fiber, due to the peculiar nature

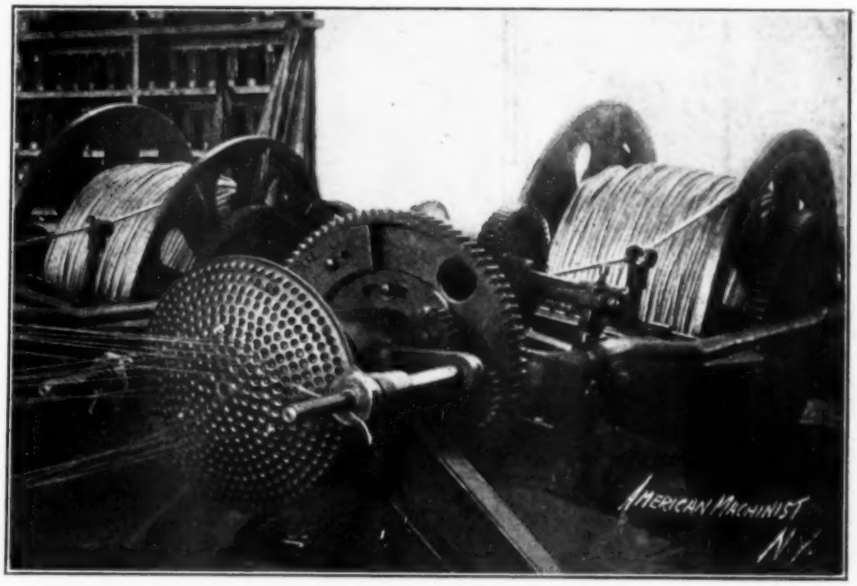


FIG. 9. A FORMER, TWISTING THE YARNS INTO A STRAND

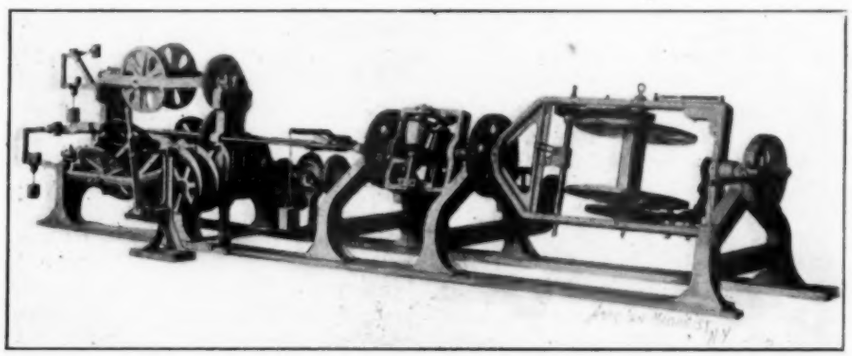


FIG. 10. A ROPE LAYER TO FORM THREE STRANDS INTO A ROPE

of the manila itself. Consequently in order to produce the best rope, the adjustment of the twists is a very particular thing to be taken care of and all the machines used in the manufacture of the strands and the rope are provided with change gearing so that the various speeds and tensions may be accurately adjusted.

Fig. 7 shows a spinning room where the slivers, coming from the cans into which they were delivered by the finishers, are passed first through another series of traveling pins or combs and then through a conical tube where a certain amount of friction is applied to the sliver while the rotating part of the machine, which is shown on the right, twists these fibers into the yarn. After being twisted, the yarn is carried along the side bar of the revolving frame which reaches over the twisted and made, the bobbin is automatically caused to travel back and forth along the central spindle of the flier so that the yarn is wound uniformly over the length of the bobbin. This yarn resembles very coarse cord and in fact one use of this yarn which is familiar to almost everyone is for binding bundles of grain on automatic harvesting and binding machinery.

Twisting the Strands

Yarn, being simply twisted fibers, is not very strong and for the purpose of making rope must be further twisted into larger strands. Part of the operation of the making of the strand is illustrated in Fig. 9, which shows a former. Here it will be seen that a number of the yarns are passed in groups through a perforated plate. Back of this plate the different yarns are passed through a tube which forms the axis of the large gear wheel shown and on the far side of this gear wheel one of a pair of capstans can be seen. The gear wheel, of course, revolves about the axis of the tube and by means of the small planetary gears shown in the halftone, the two capstans are also caused to revolve on their own centers at the same time that they are carried around with the main gear. The whole frame together with the large reel at the far end, as shown in the halftone, also revolves with the main gear and the capstans.

The effect of this rotation, of course, is to twist the different yarns into a strand and the capstans take a strong grip on the strand which makes several revolutions around each capstan, thus supplying the requisite tension and at the same time giving it the twist as the two capstans revolve with the main gear, around the center of the tube. It should be said that each one of the small yarns which goes to make up the strand is given an extra preliminary twist in its makeup, because in twisting these yarns into a strand, a certain amount of this individual twist in the yarn is untwisted again and this, of course, has to be compensated for.

Laying the Rope

When the strand has been completed and wound upon the reel, as shown in Fig. 9, these reels are taken from the forming machine and placed in the rope-laying machine shown in Fig. 10. In this view at the left-hand end will be seen three reels which have come from forming machines. Each one of these reels, when the machine is in operation, contains one of the strands which was made in the former. Each strand is led from its reel to a tube passing through the axis of the gear wheel shown in front of each one of the reels and from this point they come down together to a grooved conical block which forms a guide to each of the three strands. After this they pass through a tube in the center of the axis of the main gear which, as it revolves, carries the frame and the two capstans, as shown in the center of the halftone.

The revolution of the central portion of the machine carries with it the yoke frame at the right-hand end, carrying the large reel. While each one of the small reels at the left-hand end of the machine revolves on its own axis, it also revolves on the axis of the frame carrying each reel, although the three reels do not re-

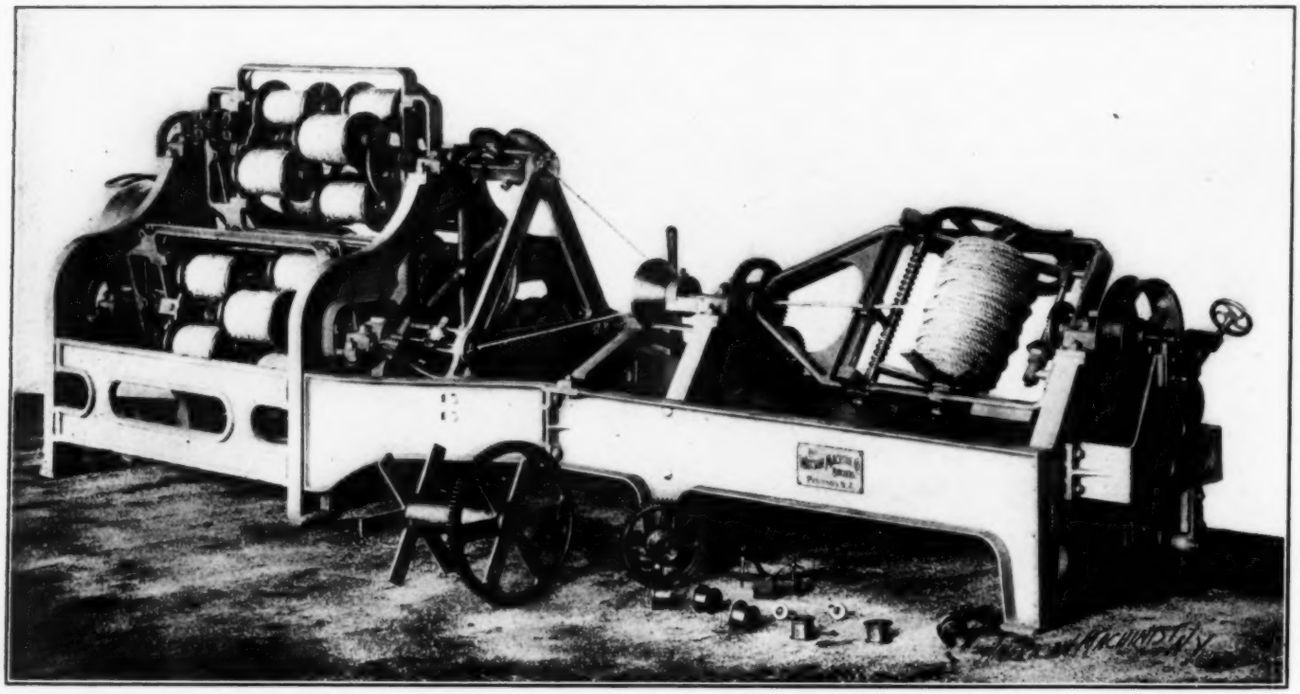


FIG. 11. A ROPE MACHINE WHICH TWISTS 24 YARNS INTO THREE STRANDS AND THESE INTO A ROPE, IN ONE OPERATION

bobbin, as shown in the halftone, to a small pulley, which in turn leads the yarn to the bobbin. The frames and bobbins revolve at about 1500 revolutions per minute, but the bobbins, of course, revolve slightly faster than the frames or as they are known, the fliers, because the yarn must be wound upon the bobbins as it is twisted.

Tension is put upon the yarn by means of two small pulleys or capstans, which are mounted on the face of the disk of the flier toward the middle of the machine. The purpose of the capstans is not only to give tension to the yarn, which is wound several times around each capstan, as they revolve on their own centers while revolving also with the flier itself, but also their traveling around the center line of the flier gives the twist to the yarn. At the same time that the yarn is being

volve around each other. The action of these three reels will be clearly understood by referring again to the crude machine shown in Fig. 8. Each one of the hooks in Fig. 8 corresponds to a reel at the left-hand end of Fig. 10 and the reels revolve on axes parallel to the main axis of the machine and at the same time by their revolving on their own axes allow the three strands to be drawn out and, as already described in connection with Fig. 8, twisted into a rope.

The two capstans shown in the center of Fig. 10 are again for the purpose of putting the proper tension on the rope and also to twist it about itself. After leaving the capstans the rope passes through the tube in the axis of the next gear wheel and finally through the traveling guide to the main reel at the right-hand end of the machine, this reel acting to coil up the finished rope as it is made. The object of the traveling guide on this frame is to wind the rope evenly back and forth along the axis of the reel.

A Combination Machine

Fig. 11 is an illustration of a combination former and layer. This machine which makes ropes of 24 yarns or threads, the finished rope being from ⅜ to ½ inch in diameter, completes the operation of making the strands and the finished rope in one process. At the left end of Fig. 11 will be seen the 24 bobbins, each bobbin carrying a yarn. These bobbins are arranged in groups of eight, each group delivering eight yarns to be formed into one strand and the three strands into the finished rope.

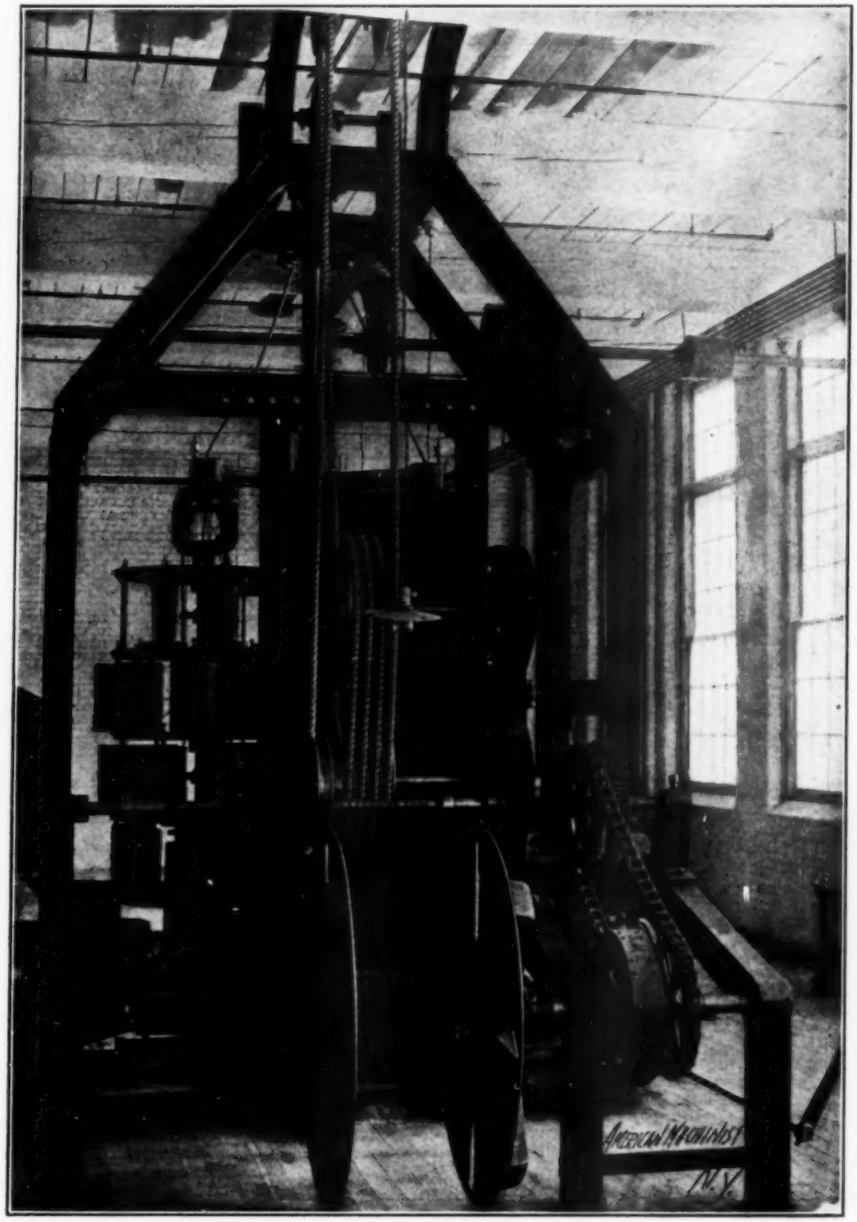


FIG. 12. LARGE UPRIGHT ROPE MACHINE MAKING ROPE FROM THE YARNS IN ONE OPERATION

Each of the three groups of eight bobbins is, of course, caused to rotate about the axis of the group. Necessary provision is made in the rotation of these various bobbins and groups of bobbins so that the yarn does not become either untwisted or overtwisted and this is accomplished by means of the frames or fliers which surround the groups of bobbins and in the halftone the strand coming from the bobbin is seen to traverse the outside of these frames or fliers, the revolution of which gives the proper twist to the strand.

In front of each group of bobbins forming a strand, the halftone shows a pair of capstans acting to give the correct tension and at the same time to twist the strand upon itself as already described. The three strands as seen are brought down to a funnel-shaped tube having the requisite guides directing each strand correctly and the final twisted rope after passing through the traveling guide on the frame at the right-hand end of the machine is wound upon the reel there shown.

Fig. 12 is another machine of the same, single process character with the exception that it is upright and suitable for larger rope, that is from ⅞ to 1⅛ inches in diameter. In this halftone the bobbins are seen at the rear of the machine, although only one of the three groups can be seen. The three groups, as before, each form a strand and these strands are twisted into the rope passing around the large capstan pulleys on the front of the machine to give the requisite tension and finally down to the large reel in the foreground.

From the various pictures it will be seen that numerous weighted levers are provided throughout the machines to act as friction brakes on the various rotating parts and the adjustment of these weights together with the speeds of the various parts, as already said, form a very important part of the art of manufacturing rope by machinery. In no other industry is the old adage so true: "to make a wrong twist would untwist the whole twist."

For the illustrations showing the laying and twisting of the rope we are indebted to the Columbian Rope Company, of Auburn, N. Y., and the Watson Machine Company, of Paterson, N. J. The halftones showing the preliminary preparation of the fibers are shown by courtesy of the International Harvester Company, of Chicago, and the Prieto Machine Company, of New York City.

According to advance reports of the United States Census Bureau, 15,072,220 miles of wire were in use in 1907 in this country by the various telephone and telegraph systems. Of this, 12,999,369 miles were controlled by telephone companies. Of this again, 5,092,223 miles were in open aërial lines; 2,917,114 in aërial cables; 4,969,302 underground and 20,730 in submarine lines.

Sectional Die for the Subpress

By A. M. Cahill

The sketches show a sectional compound subpress die which I have just completed for blanking and piercing small aluminum parts like Fig. 1.

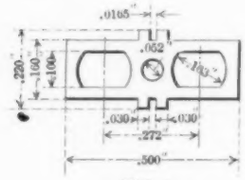


FIG. 1
The Blank (Enlarged)

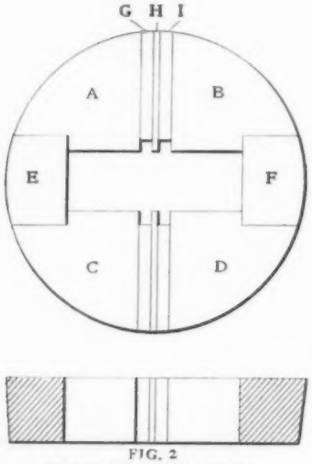


FIG. 2
Enlarged View of Die Sections

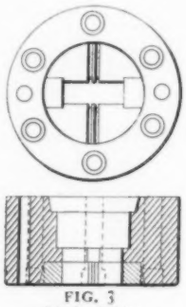


FIG. 3
Die in Holder

FIG. 5
Blanking Punch

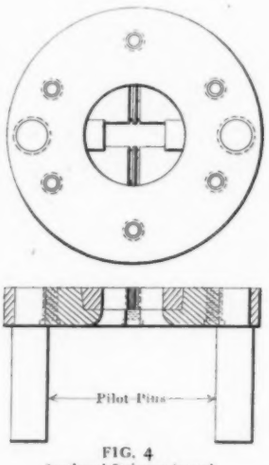


FIG. 4
Sectional Stripper forced in Holder

FIG. 11
Punch Blank

FIG. 6
Piercing Punches in Holder

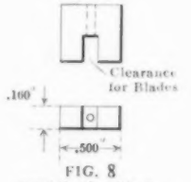


FIG. 8
Straddle Size Block

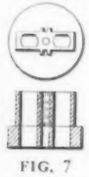


FIG. 7
Shedder

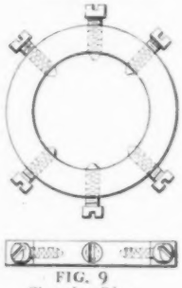


FIG. 9
Clamping Ring

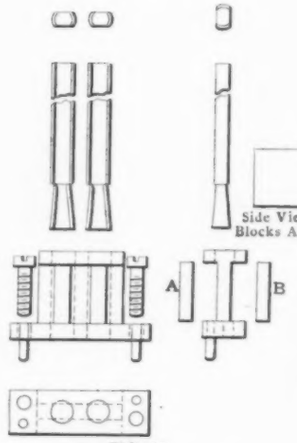


FIG. 10
Broaching Fixture and Broaches

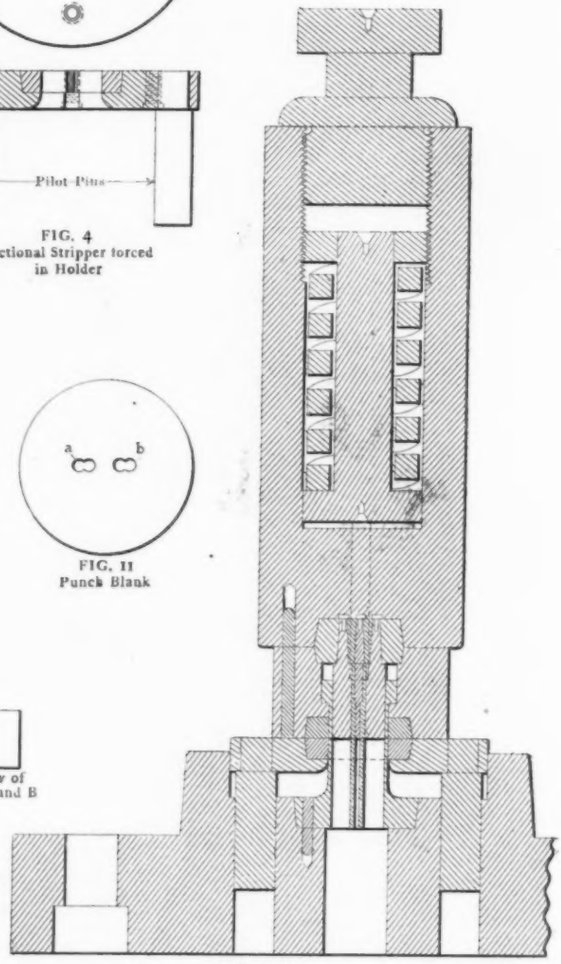


FIG. 12
Punch and Die Assembled in Sub Press Plunger and Base
American Machinist, N.Y.

SECTIONAL DIE FOR THE SUBPRESS

The die, Fig. 2, is built up of thirteen pieces and the stripper has the same number; that is, there are twelve sections and a holder in each.

The die holder, Fig. 3, is 1½ inches in diameter and the stripper, Fig. 4, about 2¼ inches diameter. Each has a chamber ⅞ inch in diameter by 3/16 in depth formed on a one-degree taper. The sections shown in Fig. 2 were all ground and lapped on all adjoining surfaces and walls, and forced into their seats with sufficient pressure to insure their being held tight without the assistance of a dowel pin or screw.

The first step in making the sections for both die and stripper was to turn up two tool-steel blanks one inch in diameter by 9/32 inch in thickness. I sweated both blanks together, soldered them to a solder chuck, placed them in the bench lathe and turned them down, making allowance for grinding to the size of the seats or chambers in the holders. I then placed the chuck in the dividing head of the milling machine and made a cut diametrically across both blanks about 0.010 inch narrower than the body of the blank, Fig. 1, which is 0.160 inch wide. In this same setting the steps were milled to receive the end pieces, *E* and *F* in Fig. 2, which also acted as distance pieces. After this the dividing head was moved one quarter turn and a cut taken wide enough to receive the set of blades *G, H, I;* in this case also allowance being made for grinding. Then we had four complete sections *A, B, C, D* in Fig. 2, for both the die and the stripper ready to be hardened and ground. After this we machined up the two pairs of end pieces *E* and *F*, then turned our attention toward the blades. The center blade was to finish 0.0165 in thickness and the outside blades just 0.030 inch. If each piece were made separately by cutting it to the figures, allowing about 0.005 for grinding, there would have been some dif-

ficulty in holding for grinding on the magnetic chuck, so it was decided to make them in three long strips, marking each piece at an approximately correct length with a file so that it could be broken apart after it was hardened, ground and lapped. Each length was marked to be divided into four parts. After the strips were finished they were broken into pairs, leaving opposite pieces tied together to facilitate matters while setting them up together, previous to grinding the periphery. Then the two sets of quarter sections and end pieces were ground. The straddle size block, Fig. 8, and the brass clamping ring, Fig. 9, were then made, the blades placed in position through the slot in the size block, the other sections put in their respective positions around the block within the clamping ring, and clamped securely with screws and all sections soldered together on the face. Next they were released from the clamping ring, soldered to a chuck in such a position that the hole in the straddle size block was dead true with the lathe spindle, and ground on face and periphery to a drive fit in the holder. We then released the sections from their anchorage, broke the tied blades, ground them to their respective lengths on the inner ends, placed them around a size block 0.160x0.500 inch, and entered them into their holders. Small size blocks 0.030 inch square were pushed into the small square openings at the blade ends so as to keep the two thick blades back in position against the walls of the holder, and thus all sections were forced into the seat in the holder.

We then pushed through all size blocks, and ground the die on face, and not the slightest evidence of a joint was visible even with an eye glass.

The Blanking Punch and Shedder

The blanking punch, piercing punches and shedder are shown in detail in Figs. 5, 6 and 7. In making the blanking punch and shedder with their two irregular-shaped holes and small round hole between, it was decided to make the two large holes first and locate the small hole afterward. It was impossible to drill and file them accurately, as the drawing called for a straight hole to a depth of 3/8 inch, and the idea suggested itself of making a fixture for broaching the two larger holes. This was very accurately made (the holes being spaced in accordance with the holes in the blank), was hardened and ground and the holes afterward lapped. Then was made a series of eight broaches, each one being 0.001 inch larger than the preceding one in diameter and thickness, except the last. This was 0.0005 smaller than the piercings in the blanks. This allowance was for lapping the holes after the hardening operation. The body of these broaches was 0.1625 inch diameter, and they were equally flatted on both sides to a thickness of 0.0995. The body of the broaching fixture was also ground to the thickness of the broach, so that when the two side pieces *A* and *B*, Fig. 10, were clamped to the sides of the fixture, the broaches were bound to be in line while being forced through.

The punch blank was large enough in diameter to give the broaching fixture a suitable seat, and was 3/4 inch in length. This blank was soldered to a piece of flat stock and laid out by sliding it along on a parallel, using size blocks for spacing. The holes were bored in pairs, that is, one hole did not remove stock enough to allow the first broach to be pushed through easily, so two holes were bored to open into each other, as in Fig. 11. We located the broaching fixture by placing in the two outer holes *a* and *b*, Fig. 11, two shoulder pins, the large ends of which were about 0.1 inch in diameter. I then clamped the side pieces *A* and *B*, Fig. 10, to the fixture, slipped it over the pins and screwed and doweled it in place. The shoulder pins were next removed and the series of broaches pushed through successively. The shedder, Fig. 7, was handled in like manner and when completed it was found that the holes were free from roughness, measured dead to size and the flat sides were parallel. Then the outline of both punch and shedder was milled; here we found it necessary to have a good sharp mill, and not force the feed, in order to prevent the holes from changing both in shape and position. We then located the center hole, shaved both punch and shedder, hardened the punch, lined it up face to face with the shedder and transferred the center hole to the shedder and hardened the latter. A steel lap was made to suit the holes in the blank, and with a little fine diamond powder both holes were lapped to size. After this the die was clamped true on the faceplate, the stripper slipped over the punch, the punch entered into the die, and the outside of the stripper and the base of the punch ground to fit the base of the subpress. Thus the punch and die were bound to be in line if the base and the body of the subpress were bored concentric.

Piercing Punches

The next thing to make was the piercing punches and holder, Fig. 6. The piercing punches were put in on a taper of 1 degree and held from behind with screws. The two large punches were made in one piece, which was turned up on centers, hardened and ground. Then it was placed on the magnetic chuck and the flats ground central. That finished the difficult work on this set of press tools, which is shown assembled in the sectional view, Fig. 12.

After the press and tools were fitted up a few blanks were turned over to the inspector, who found that the greatest variation was not over 0.0002 inch, and I fully believe that this variation was due to the extra pressure of the spring operating the shedder, for each opening in the die when tested would just receive a size block.

A Novel Way of Cutting a Bevel Gear

By Clifford P. Wicks

There are a number of ways of cutting bevel gears, with varying degrees of accuracy, as everyone knows. In our shop there were no bevel-gear cutters of any kind, as all such work was sent to Brown & Sharpe; but we had a good equipment of spur-gear cutters. Sometimes these were used on hurry repair work for bevel gears having a narrow face, when no great accuracy was required.

One of our superintendents has a reputation for wanting what he wants when he wants it, and also of getting it. One day he wanted a bevel gear for his automobile "immediately if not sooner." The turning of the blank was a simple matter, but the cutting of the teeth was another proposition, as the gear had a 1 3/8-inch face, which was very wide for a pitch diameter of 3 1/2 inches. This made the change in the size of the teeth considerable. There were 28 teeth which gave 8 diametrical pitch, and by using a little trig the size of the teeth at the small end was found to be almost exactly 10 pitch. This gave a clue to the solution of the cutting problem.

The gear was set up on the index head at the angle of the bottom of the tooth and a cut made through each tooth to the proper depth with a plain milling cutter about 3/32 inch thick. Then a cut was made on the large end with an 8-pitch No. 4 cutter, in line with the milled slots; and on the small end with a 10-pitch No. 4 cutter. Both of these cuts were run into the blank to the proper depth, and until the edge of the gear blank was under the center of the cutter arbor. This gave the proper layout at each end of the gear. It was a very simple matter to work out the metal to these two layouts by using the plain milling cutter, which had side teeth, and corners rounded. To do this, the gear was revolved out of center on the head, and the cutter set off center a corresponding amount; somewhat as is done in cutting bevel gears in the regular way. After getting a proper cut on a tooth, the same cut was taken on all of the teeth, before resetting the cutter and gear for another cut. It needed two cuts with the plain cutter on each side of each tooth to finish the job. As these cuts were light, they were run through at a good speed so that the total time on the job was not bad. This made seven cuts on each tooth. However, the gear did not require any filing and ran satisfactorily.

Pipe Patterns for Single Castings

Converting T Pipe to Elbow, Making Double Ell from a Single, Making S Pipe Pattern on a Curve, and an 8 in. Pipe with Two 5 in. Elbows

BY W. PETERS

I fancy I hear someone say, "well, what about pipes," for patternmakers as a rule turn up their noses at the mere mention of this particular branch or part of the trade, and, secretly or otherwise, have a great contempt for the job of pipe making. One can to a certain extent understand this feeling when one considers the usual conditions under which the patterns are made, or to use the shop term, got ready for the foundry.

Most of the work is done by patching up, and makeshift expedients on old patterns. Sometimes a good imagination is required to be able to call them patterns at all, and it is interesting at times to hear what the molders have to say about them; one man said the next thing he expected to get was simply a hole to run the metal around.

Of course, the above remarks do not apply to standard straight lengths or bends for which special patterns, etc., are used, but to those odd, irregular, or crooked pipes that are of all shapes and sizes.

Things Patternmakers Must Know

To be what one might call a thoroughly good pipe patternmaker, a man must be a bit of a genius, for if the work is to be done economically and quickly he must be able, not only to determine the best way of getting the pattern ready, but should also know when and how to utilize existing pattern stock as much as possible. At all times he must be ready to devise ways and means for reducing the cost of labor and material, and have some idea as to the capacity and limits of the molder's abilities, foundry appliances, etc. At the same time it is not always policy for the patternmaker to get the pattern ready without first consulting with the molder. I do not mean to say that the patternmaker could not manage to rig up something that would mold, but there are certain little details of construction and "I can make that do" kind of work which a good molder always has up his sleeve; something that however good a man the patternmaker may be, he cannot know, as this knowledge is only acquired through actual experience, and contact with the molder's art, and it tends to make either a cheaper or better casting.

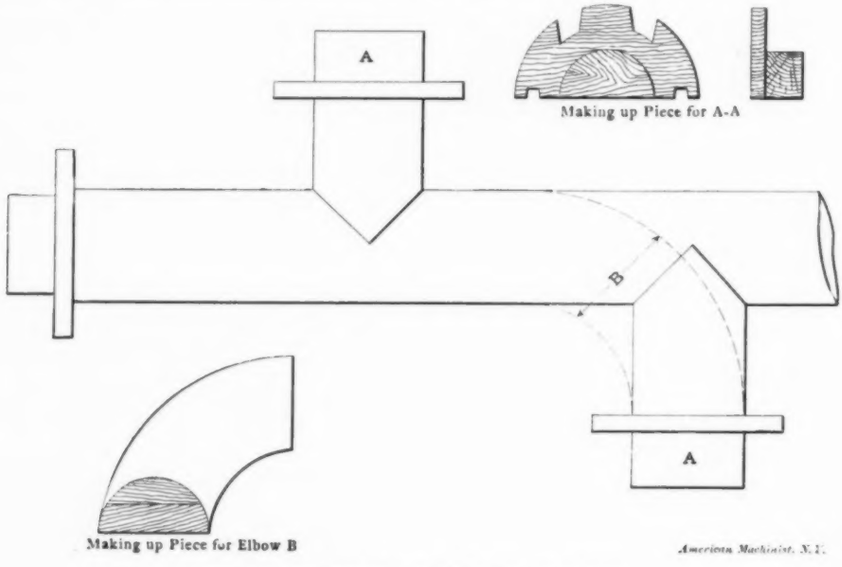
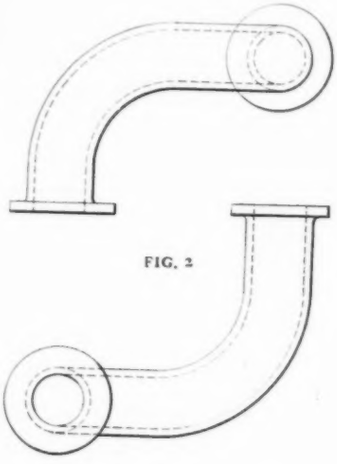


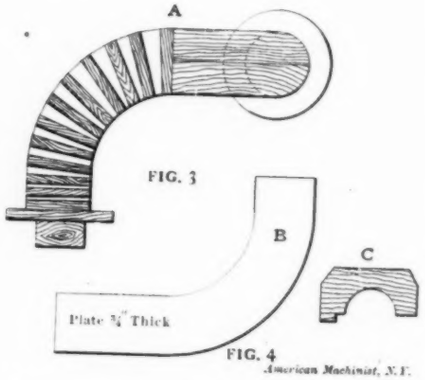
FIG. 1. CONVERTING A T-PIPE INTO AN ELBOW

Converting Tee to Ell and a Double Ell

In Figs. 1, 2, 5 and 8 are shown sketches of pipes, which although comparatively simple to some, have actually been made. Although similar ones, in one form or another, are frequently being made in foundries where work of a varied character is done, it will perhaps help the younger members of the trade to form some idea as to how they might proceed to get the patterns ready. It is not claimed that the methods described are the best, but they answered the purpose, and with good results.

In Fig. 1 is shown one of the most common forms of a making-up length, that requires no more than a passing notice. The method of making this is obvious, of course; it is assumed that there is no elbow pattern of the required size in stock and consequently a *tee pipe* pattern is used with the making-up pieces shown. In Fig. 2 is shown a double bend. We had only one elbow pattern in stock, so we made a skeleton elbow for the other part and joined it at *A* at right angles to the other pattern, as shown in Fig. 3. As will be seen, the making of this pipe pattern is not so difficult as would at first appear. The same remarks also apply to the core; this is made in two portions, and buttjointed in the center, chaplets being used to keep the two ends in position. At *B* and *C*, Fig. 4, are shown the strike and core plate that are used for both parts of the core.





MAKING A SINGLE ELL INTO A DOUBLE ONE

An S-pipe Pattern

In Fig. 5 is shown a curved S-pipe somewhat similar in appearance to the one shown in Fig. 2, but totally different so far as making it is concerned, as it is much more difficult and expensive. This pipe had to be made with a curve to

carry it over the pipe *D*, which was already fixed in position. In Figs. 6 and 7 is shown how the pattern and core plate were made. Two pieces of 2½-inch timber are cut out and screwed together to form the curve, as shown at *E*, then a piece about ¾ inch thick is cut out to the same shape and width as the outside diameter of the pipe. This is then saw-nicked so that it can be bent around and fastened to the curved pieces, as shown at *F*. The core plate is now cast from this, and it is always advisable to allow this kind of plate to remain in the sand as long as possible to minimize the

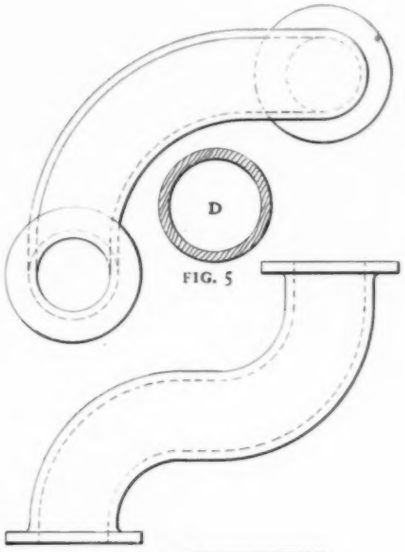


FIG. 5

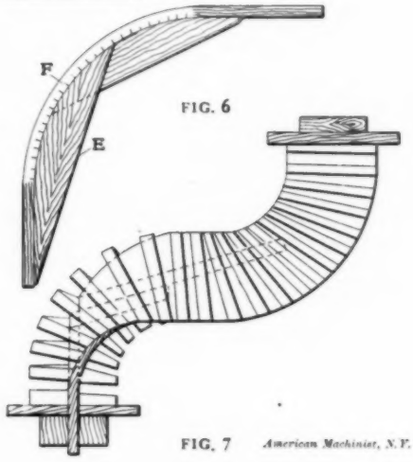


FIG. 6

FIG. 7 *American Machinist, N.Y.*

PATTERN FOR A CURVED S-PIPE

risk of their getting out of shape while cooling.

Half cores are made from each side of the plate by means of a strike similar to the one shown at *C*, Fig. 4. When the two half cores are put together they will not be an exact fit. This is owing to the difference in the radii caused by the thickness of the plate having been in between. This difference is so little that it may be ignored, and a bit of rubbing, or a little loam put in between, will make a joint without materially affecting the diameter of the core.

Two Ways of Making a Pattern

There are two ways of making the pattern and these will depend on a combination of circumstances, the molder, and the patternmaker. One way is to strike an extra thickness of loam on to the core and use this for the pattern. If done this way the core plate, Fig. 6, will have to be made correspondingly wider to allow for a bearing for the strike, when putting on the extra thickness of loam.

The other way is to utilize the templet and make it into a skeleton pattern, as shown in Fig. 7. Any old lumber will do for the segments.

There is very little difference in the cost of the two methods; the former way is a

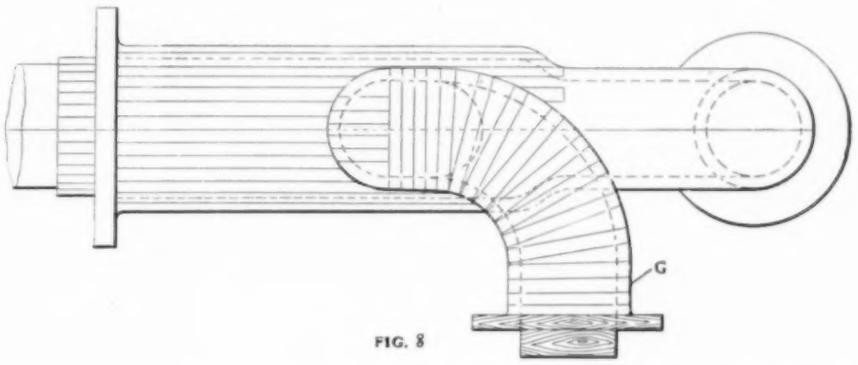


FIG. 8

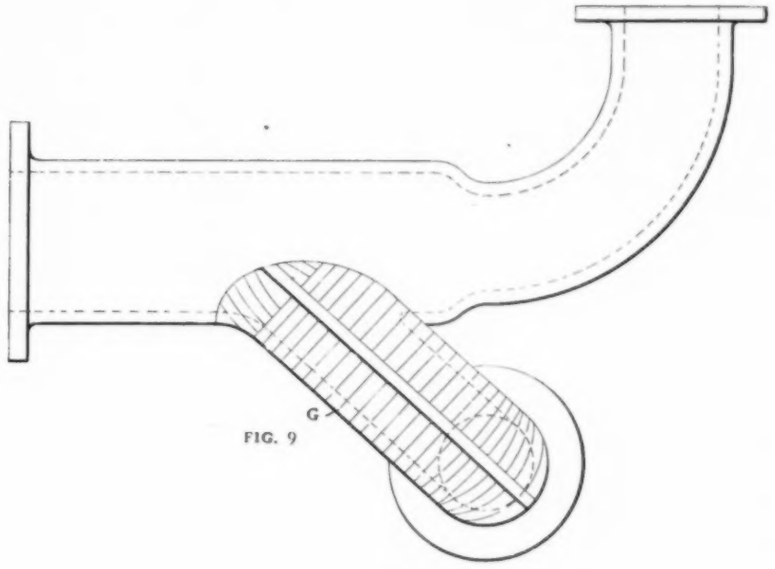


FIG. 9

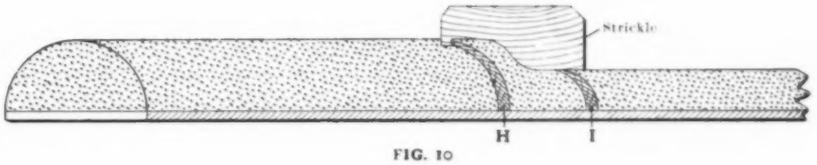


FIG. 10

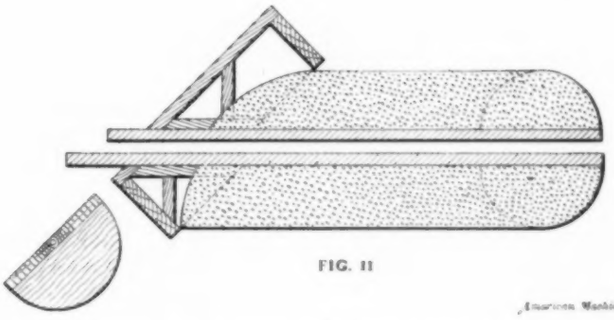


FIG. 11

American Machinist, N.Y.

MAKING AN 8-INCH PIPE PATTERN WITH TWO 5-INCH ELBOWS

little cheaper and the thickness of metal is more sure of being uniform, but owing to the extra drying required it takes a longer time to get the job out. We made the pipe the latter way as it was wanted in a hurry, and the skeleton was put together and molded while the core was being dried.

Pattern for 8-inch Pipe with Two 5-inch Elbows

In Figs. 8 and 9 is shown a reducing pipe, where an 8-inch feeds into two 5-inch pipes. We had a 5-inch elbow stock pattern and used it for this job. The 8-inch inlet, straight end, was made from a 5-inch pipe that was lined around with lags to make up the necessary diameter, and a skeleton piece was made for the elbow *G*, as shown in the line cut.

The main core may be made in two portions: the straight length, including the reducing part, as an ordinary straight core; that is, with a horizontal board; and a core plate for the elbow. Or it can be made on a single-core plate, as shown in Fig. 10. There a half flange *H*, the size of the large diameter, and another half flange *I*, the size of the small diameter, are fixed in their respective positions. The reducing part is then formed with a strike, as shown.

The core for the branch elbow in both cases is made on a separate plate; the end that fits the pipe is shaped by a templet cut to the diameter and angle required. Two of these templets are required, one for each side of the plate, as seen in Fig. 11. The core irons should be left short to allow for rubbing to a fit if necessary.

The pipes which have been illustrated are not by any means the most difficult that the pipe hand has to tackle, but they may give some idea as to what is expected from him, and the way he sets about the job often makes the difference between the casting that makes, or loses, a profit.

Shooting by electrically lighted sights sounds rather novel, but army rifles equipped with this unique device are reported as being made at the United States Springfield armory. To those who have had experience in handling rifles outdoors in the twilight or night it is known that while the object being fired at can be seen, owing to its size, it is almost impossible to take aim with a great degree of accuracy by means of the sights. In the rifles being manufactured to overcome this difficulty there is fitted to the stock a battery which serves to light a tiny electric bulb placed on each side of the gun barrel. The current is controlled from a button on the trigger guard and when the button is pressed the miniature lamps serve to light the rifle-sight range while the lights themselves are shielded from view.

The Infancy of the Automatic Screw Machine

By H. E. Curtis

In the village of Brattleboro, Vt., in the year 1871, the first automatic screw machine was made. The inventor and maker of this machine, Francis Curtis, was a cabinetmaker, born in Canada, where he lived until 1865, when he came to the "States" with his family, and finally settled in the above named village to follow his trade.

He had his own little shop, and made spindle bedsteads, which were so popular at that time, and other furniture. He always had an inclination to tinker with machinery, and was ever anxious to take up this line of work in preference to cabinetmaking.

The opportunity finally presented itself, as he had, by industry and careful saving, succeeded in accumulating $1000 besides paying for his home. He invested this in some machinery, among which was a planer, an engine lathe and speed lathe, and he set about making a few velocipedes. He built a dozen or more of these velocipedes, and it was a curious sight to see him riding about the little village, the observed of all observers, to whom he appeared as one bewitched, for the idea of riding astride two wheels was almost unknown. His two oldest sons soon learned to ride the machines, but could not be induced by any argument he could use to ride through the town. He sold the machines to some of the young men in town after teaching them how to ride, but before he started on another lot his plans were diverted by a remark made to him by a man for whom he was doing some work. This man picked up a screw from off the bench and, after looking at it a moment, said:

"Frank, why don't you make a machine for making these screws automatically?"

That was all the hint my father needed, and he said after a moment or so:

"I can and I will."

His mind was made up, for in those few moments he saw the machine which has proved to be one of the greatest labor-saving devices of the 19th century. He went about at once to plan the machine, with the result that within 11 months from the day it was suggested he had a com-

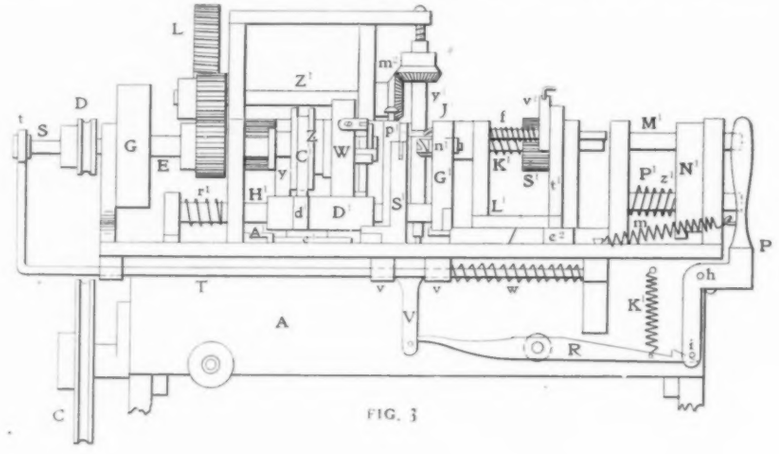


FIG. 5

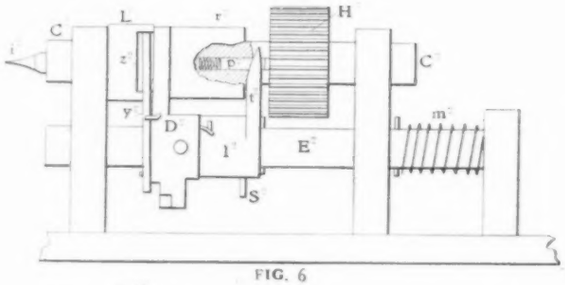


FIG. 6

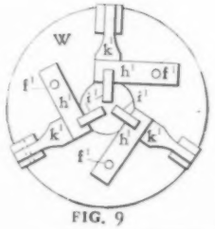


FIG. 9

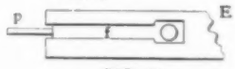


FIG. 10

FIG. 11

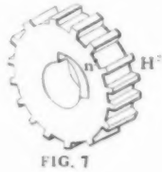


FIG. 7

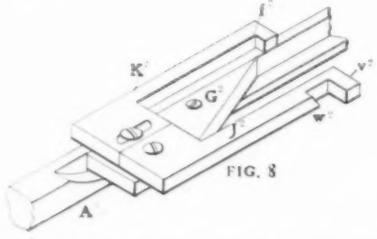


FIG. 8

American Machinist, N.Y.

PATENT DRAWING OF AN AUTOMATIC SCREW MACHINE

plete machine finished and running. It was built without drawings, except for a few pencil sketches of some of the details. He seemed to know from the beginning just what the machine was to be like and how the different movements were to be accomplished. He, of course, had some difficulties to overcome; this he did without assistance from anyone.

The machine had a hollow spindle upon which was a pulley for driving it. An inner tube fed the wire up to short lengths. A three-jawed chuck held the wire as it rotated. The box tool was then fed forward to turn down the stock for the body size of the screw. It would then back off and a carriage with two spindles thereon (one holding a threading die and the other a chuck for receiving the screw from the screwdriver, which will be mentioned later) would come forward and push the box tool, which was pivoted to the frame of the machine, back far enough to take its place so that the die was in line with the spindle or screw blank. An arm would then push the die onto the blank and cut the thread to the required distance. It would then revolve with the spindle until the cutting-off tool, which was already in the act of cutting off the blank, should finish doing so. The carriage then went ahead a short distance to a header, which would form the shape of the head. Meanwhile the chuck would open, the wire feed would push the wire ahead the proper distance for a new screw, the chuck would tighten, the box tool would return to its position in line with the spindle and repeat its operation as before. When the header had done its duty it would drop back and allow the carriage to go ahead again, quickly at first, then it would go slowly past a slotting saw, held on an arbor in a vertical position, which would slot the screw, then forward again quickly to a screwdriver which was held in line with the saw. The screwdriver had flexible springs with hooked ends above and below to hold the screw; it would rotate and draw the screw out of the die. The carriage with the die and second spindle thereon would then return as before to thread the new screw that had been formed on the end of the rod. At the same time the die is cutting the thread on the new screw the jaws of a chuck on the second spindle would open and receive the screw from the screwdriver, which would come forward and stop with its blade in line with the saw as before.

The jaws of the chuck on the second spindle would close, and when the new screw was cut off the carriage would go ahead again to the header and repeat its work of forming the head, etc. At the forward and remove the bur left by the forward and remove the burr left by the saw and finish the head of the first screw. Then both headers would drop back and the carriage would go ahead again. By the time the second screw had reached the screwdriver the first screw would be pushed out of the chuck into a pan placed there to receive it, all finished and away from all the chips, and so on; all day it would spit out screws as long as there was wire in the machine, at the rate of from 1000 to 3000 screws a day. When the end of the stock of which the screws were made would pass out of the wire feed the machine would stop automatically and ring a bell to notify the operator that a new bar of stock was required. The machine was made to take in ½-inch stock, and make a screw up to 1¼ inches long, both plain or shoulder screw, round, flat, or fillister-head, and these with remarkable uniformity considering the crudeness of the machine, for remember, it was not made by an expert machinist, but by a cabinetmaker who must, of necessity, have learned as he went along the important details of machine construction. The several spindles were driven by a chain of spur gears, the slotting shaft by miter gears and the cam shaft with a worm gear, all of which he made himself on his engine lathe. We today do not think anything of getting out these parts with the improved facilities at hand.

The screwdriver was a wonderful piece of mechanism. I will not attempt to describe it more than to say that when the screw reached it there would be a click, it would rotate and move backward at just the proper speed, which was adjusted to take the point of the screw away from the mouth of the die without giving it a chance to spoil the thread and yet not too soon to allow it to leave the screw in the die, and when it returned to put the screw in the chuck, it would stop in just the right position to be ready for the next screw. I reproduce the old patent drawing and this movement, as can be seen in Fig. 6. It was not unlike the action of the shaft in an ordinary punch press which draws the pin to cause the slide to come to rest at the top of its stroke. The edge of the screwdriver on which the screw would slide was slightly beveled to enable it to enter the slot readily.

I never tired of watching this movement; it was so human in its action, and many people came hundreds of miles to see the machine in operation.

The facilities for protecting a patent at that time were very crude, and he was unable to cover his ideas in such a manner as to secure any protection.

One of the most vital points in his invention was neglected—the inner tube *S*, shown in Fig. 3, that feeds the wire in the machine, was mentioned so vaguely that it was not protected.

This and the die holder and the stops were not unlike those used to the present day for the same purpose. One of these screw machines was at the Centennial Exposition held in Philadelphia in 1876, and another at Paris in 1878, at both of which he secured the highest award, together with special mention in the records.

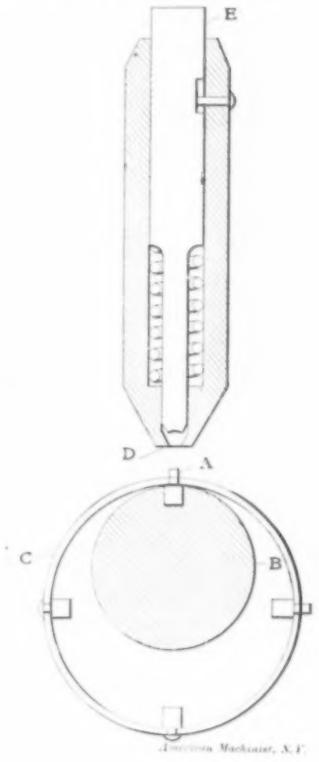
Hundreds of very important achievements have since been accomplished, in the line of automatic screw machines, but I have yet to learn of any that went so far, in the way of really making an automatic screw machine; that is, one where the screw dropped from the machine absolutely finished.

[Almost all watch screws are finished before they leave the machine. We recently saw a machine which made a pound of finished screws from a pound of wire, the only scrap being a few inches on the end of each reel of wire.—ED.]

A Riveting Tool

BY A. M. JONES

Recently I had some small ferrules which had to have four pins firmly riveted into them. At first we riveted the pins with a cross-peen hammer, but on account



A RIVETING TOOL

of the pins being only 1/32 inch in diameter it made a very unsatisfactory job, as regards both appearance and strength. I show herewith a sketch of a small and cheap fixture, made from a piece of ½-inch drill rod, which overcame this difficulty.

The pin or rivet *A* is placed in the anvil *B* and the ferrule *C* is pressed down over the rivet with the fingers. The hole in the device *D* is then brought central over the pin and pressed tightly against the ferrule, while at the same time two or three light blows struck with a hammer on end *E* rivet the pin firmly and leave a nice round head.

Notes on the Design of a Grinding Machine

By Con Wise

Some little time ago one of my friends seriously thought of entering the grinding-machine business in competition with Landis, Brown & Sharpe, Norton, *et al.* He asked me to look over the field as to design, profits, etc. The matter of possible profit in this line I prefer to pass over in silence, simply saying that he never entered the business, and, I think, never will. The design which we evolved, however, had some points of novelty which may be of interest to the general public, as well as to those already in the business, and the process of thought which we went through in order to arrive at our conclusions may also be interesting. All technical professors and scientific designers, however, will save themselves a lot of bother if they do not read further. Likewise they will be conferring a benefit on the world of design if they persist in reading further and tell us all where we were wrong and why.

This machine was specified to be what is known as a plain grinder, for work up to 8 inches diameter by 42 inches long, and to grind cylindrical work and taper work up to, say, 1½ inches per foot. It was to be the beginning of a line to cover all requirements, so I will endeavor to leave out all questions of dimensions; quite an important item in design, to be sure, but one that is easily filled in by any man who is likely to risk taking a job as designer of such machines.

Traversing Wheel vs. Traversing Work

The very first consideration that bothered us was the question of whether the work or the wheel should traverse. We drew the diagram of Fig. 1 in all the possible combinations, arriving at the form shown. The wheel and work must both revolve making two running fits which cannot be avoided. Two sliding fits are necessary, the cross-feed for sizing the work and the longitudinal traverse of the work or wheel. If we put both of these on either side between the wheel and bed, as is done, or both between the work and bed, as in no machine that I know of, we get two chances for give in the joints on one side, and more in the other. We thought that to put both on one side would cause any looseness of fit in one joint to be multiplied by that in the other, while by dividing the joints, as shown, each looseness would only be added to the other.

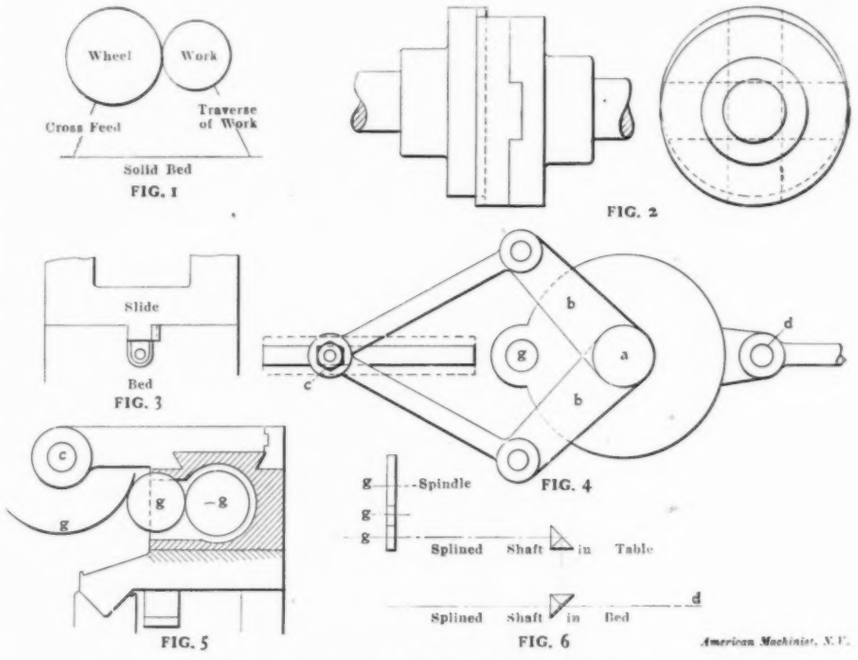
Whether to divide the two slides as indicated in Fig. 1, or to put the cross-feed under the work and the traverse under the wheel was a matter which took care of itself as soon as we thought that the work to be provided for was necessarily long, and that a cross-slide under it was an awkward thing to design and be sure that the two ends of the work were advanced or withdrawn equally.

If the wheel cuts downward, as is usual, then the pressure on the work is downward and on the wheel upward. When roughing this pressure may be considerable; when finishing it may run to almost zero. It will approach zero faster just in proportion as the two centers, wheel and work, are rigidly held. Theoretically, if the work and wheel centers are held perfectly rigid the second traverse of the wheel should only have to take off the amount which the pressure between the two compressed the material of the wheel and the work. Practically, and I do not know but theoretically on another ground, we wait a long while before succeeding traverses of the wheel fail to show perceptible sparks. This pressure on the work being downward tends to aid gravity and make the holding of the work (omitting center rests for the time being) the simplest thing, because if the centers fit at all well all the tendencies to motion are in the same direction.

The wheel, however, as usually designed, is held down by its own weight and the pressure of the cap over the bearing, and up by the abrasive force on the work and the pull of the belt. With all these forces acting and all variable except the weight it is rather remarkable that we can get uniform grinding. We proposed to drive without belt pull and with no caps on the boxes except to keep out dust and to keep the wheel from flying out in case of accident. We proposed making the wheel and the spindle as heavy and massive as possible, and to depend on that weight to hold the wheel up to the work.

Here is a curious thing. We think of a 10-pound casting, a ball, resting on a bench. If we lift on it with a 9-pound pull then there remains only one pound pressure between the ball and the table, but there is no more likelihood of the ball flying up from the table than before. It takes the whole 10 pounds and then some more to start it. Our spindle then will be in perfectly stable equilibrium until a pressure is brought on it sufficient to overcome its weight.

No data are available as to the pressure of feed or cut on different grades of emery wheels to remove the material at a given rate. All that we could do was to hang up a bar of steel and then another of cast iron in front of an emery wheel by means of a spring balance. Then we pressed the bar up against the wheel until the sparks came off about as we expected to see them and read the balance, deducting the weight of the bar. This was a terribly rough way of getting at it but we concluded that 10 pounds tangential pressure between wheel and work was a fair average for roughing, which is not so strange when we figure that 12 pounds pressure with the wheel running 5500 feet per minute uses up 2 horsepower. A 14x2-inch wheel with the centerpiece will probably weigh about 20 pounds which, with the lightest possible spindle, would give plenty of pressure for the ordinary run of work. To be on the safe side we planned to make the spindle and the centers and flanges for the wheel as heavy as we dared, bringing the total weight up to some 40 pounds. All this is not effective, however, since it is very difficult to use an outboard bearing, which would be necessary if we were to equalize the weight outside the wheel on each side. We found



DIAGRAMS OF DETAILS OF A GRINDING MACHINE

that we could get 30 pounds effective weight at the wheel, that is, it would take an upward pressure of 30 pounds to stir the wheel from the bottom of the box.

This 30 pounds resistance applied at the surface of a 14-inch wheel running at 1500 revolutions per minute will use up 5 horsepower without any allowance for friction. On larger machines, of course, the weight of wheel and spindle is greater so that more power can be used without difficulty from the lifting of the wheel in its bearings.

The Spindle Drive

To drive the spindle without belt pull is easy. All that is necessary is to have the driving pulley turn on the projecting ends of the bearings in which the spindle turns and then drive the spindle by balanced dog pins. One of the things that we were after, however, was to get a neat self-contained machine, and to accomplish that result we placed the countershaft or main driving shaft on the floor at the back of the machine and belted up to a cone pulley on a swinging frame. The cone-pulley shaft was then connected to the wheel spindle by means of an Oldham coupling, Fig. 2, so that if its axis did not coincide with that of the spindle it would drive just the same, which was made necessary by the pulley shaft swinging in the arc of a circle while the wheel spindle traveled in a straight line. By this means a drive was obtained which allowed of as large a number of steps on the cone as could be wanted without making the spindle unduly long. The short belt drive is open to objection but if properly designed and the two cone pulleys are not two widely varying in size it could be made very satisfactory.

Slide for Wheel Carriage

The next question was the form of slide for the emery-wheel carriage. Two vees, one vee and a flatway, a flat slide with either square or bevel lock gib were suggested, with the result that we decided on the scheme shown in Fig. 3, which is simply a flat surface held down by the weight of the carriage itself and guided by a square tongue running in a groove with a taper packing on one side. This is perfectly secure against motion in all directions except up, and there is nothing to make it go up. The top of the bed can be scraped to a surface plate and the taper packing insures an easily regulated fit sideways.

Cross-feed Mechanism

The cross-feed screw we designed as an ordinary square-thread screw cut with great care on a lathe with an accurate lead screw. There were to be two nuts on the sliding carriage, one movable lengthwise of the screw relative to the other so that all play could be taken out. Both nuts are as long as possible and get the required motion of the carriage. The cross feed itself was actuated from the rack on the table by the means indicated in Fig. 4. The shaft shown in the end view at *a* has a pinion on its inside end running in mesh with the table rack. This pinion and shaft turn first in one direction and then the other as the table reverses. On the outer end of the shaft was a friction device similar to that used on small planer for feed, except that the cover of the friction could only move between the variable stop arms *b b*. These stop pins were varied in position by swinging around the shaft *a* as a center and were moved by sliding the bolt *c* back and forth in a tee slot cut in the front of the bed. Pins *d* and *g* were so located relative to the ratchet on the cross-feed screw that they drew back the pawl and advanced it an equal amount at each reversal of the table, thus giving a feed at each end of the stroke, the amount of the

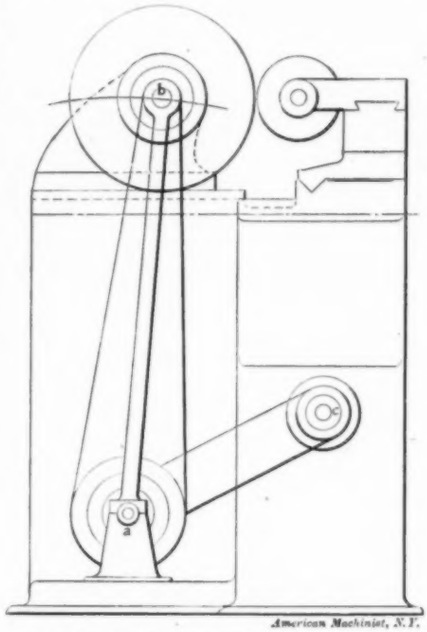


FIG. 7. DIAGRAMMATIC END VIEW OF GRINDING MACHINE

feed being determined by the position of the bolt *c* and could be set from one tooth advancing the wheel one eighth of a thousandth up to any feed that could be wanted. A knockout bar was also arranged to be set to throw the pawl out of the ratchet at any desired position but there was nothing novel about it.

The same considerations obtained in considering the work table as the cross slide but in this case the length of the table precluded the possibility of using the same design, on account of the great length of taper packing that would be required; so we fell back on the single vee and one flatway, putting the driving rack close to the veeway, or rather we determined on the single vee because the most convenient place for the rack was out of the center of width of the table. It it had come in the center we would have used two vees.

The Table and Heads

The cross-section of the table and attachment of heads shown in Fig. 5 was arrived at mainly from considerations of convenience in getting power to the headstock to revolve the work. After the design of the ways on which the table slides and the position of the work centers *c* is known, no change in the design of the table connecting the two, whether triangular, rectangular or gooseneck can change the pressures which the table will exert on the bed. To control the water used to cool the work we built up the table nearly to the hight of the centers and then had the heads reach out over the space to the centers, as shown. Center rests were also attached in the same way as the heads. The work drive was, as is indicated in Figs. 5 and 6, through a horizontal shaft *d* driven by a variable-speed device from the countershaft on the floor back of the machine, through a pair of sliding miter gears to a vertical shaft passing through the center on which the top part of the table turns for grinding tapers, then to the left by a splined shaft to the work driving head to which power is transmitted by a train of three spur gears *g g g*. The headstock could be moved up to within two or three inches of the center. The drive was thus all self contained and without trappy or exposed parts. Fig. 7 shows a diagrammatic end view showing the countershaft *a* driving the emery-wheel shaft *b*, the work drive through the shaft *c* and a variable-speed device in the bed of the machine. This same shaft *a* also carried a pulley to belt to the usual reversing gearing to traverse the table back and forth and also to the pump for the water supply, so the machine was self-contained without any awkward projecting arms or parts.

Few people realize the huge industry that the wood-treating plants of this country have built up. There are 64 timber-treating plants in the United States and during the year 1908, these plants used more than 56,000,000 gallons of creosote and nearly 19,000,000 pounds of zinc chloride, besides small quantities of crude oil, corrosive sublimate and other chemicals. On the assumption that one gallon of creosote or one-third pound of zinc chloride will protect one cubic foot of timber from decay, which is about average, more than 100,000,000 cubic feet of cross ties, poles, piling, mine and other timber were treated last year. From statistics compiled by the Forest Bureau there were used by the railroads of the country during the year 1907 alone 19,856,000 cross ties, which had been treated with some preservative, which when understood explains the continued experiments being carried on to find a suitable substitute for the wooden cross tie.

Sampling and Analyzing of Coal

The Method Used by the United States Geological Survey Which Involves a Determination of Everything That Affects Heat Value

SPECIAL CORRESPONDENCE

This subject, even although it is of a chemical nature, is of interest to mechanical engineers in general and to all those who have the responsibility of purchasing coal and of obtaining the best results from its use. During the last two years much has been written concerning the purchasing of coal on a heat-unit basis, in regard to fair and usable specifications for the purchase of coal on such a basis, and in regard to the actual results that have accompanied this procedure. However, but little has been presented in regard to the methods which must be employed to sample properly a carload, trainload or cargo of coal that has been purchased under such specification, and concerning the necessary steps to test these samples after they have been obtained, and get a representative analysis of the coal that has been delivered. It is purposed to present briefly the method used in sampling and testing by the Technologic branch of the United States Geological Survey.

The Sampling of Coal

As a preliminary to this question of sampling we quote below a section of a specification prepared by J. E. Woodwell, formerly of the Treasury Department, and contained in an engineering paper by him entitled, "The Purchase of Coal Under Specification."

"Four or more large scoops of coal shall be taken from each carload as it is being unloaded, so as to get a fairly equal proportion of fine and lump coal. These samples will be placed at once in a tight-covered barrel in a cool place.

"At the end of each month the contents of the barrel will be dumped on a clean floor, the lumps reduced to about the size of a walnut and thoroughly mixed and quartered. This mixing and quartering will be continued until the final quarter can be contained in a 2-pound galvanized-iron can sealed with insulating tape. Cans will be labeled for identification and one of them sent to the chemist for analysis. The others will be kept by the department for 30 days after the chemist's report.

"The chemist will analyze the samples sent him and deliver to the water engineer a written and signed report of the results of his analysis."

The general method of securing carload samples of coal as now practiced by the Technologic branch of the Survey is to secure portions of the coal as it is being unloaded, so that the sample secured represents the coal in the car from top to bottom. In securing this sample the inspector is careful to secure lump and fine coal in proportion as nearly as possible as exists in the car. The method of securing samples varies largely because of the facilities for unloading. When a bottom-dump type of cars is used and it is possible to do so, the sample is secured from time to time as it flows from the gates. If the car is unloaded by a hoist bucket, the sample is taken from the bucket at regular intervals. In cases where it is impossible to secure a sample from the car after being unloaded, the sample is secured from various places on top of the car, usually six or nine points are selected, which are symmetrically situated with respect to the car. In order to minimize errors due to the accumulation of dirt and cinders during transit, and also extremes of weather conditions which may have existed while the car was in transit, the sample is taken at a depth of not less than 10 to 12 inches below the surface. This method is not as likely to insure as representative a sample of the coal in the car as when a sample is secured from the coal as it extends from top to bottom, because the coal is mixed with more or less extraneous matter of different specific gravity than the coal, the continued jarring effect of train transit tends to segregate the heavier particles toward the bottom of the car.

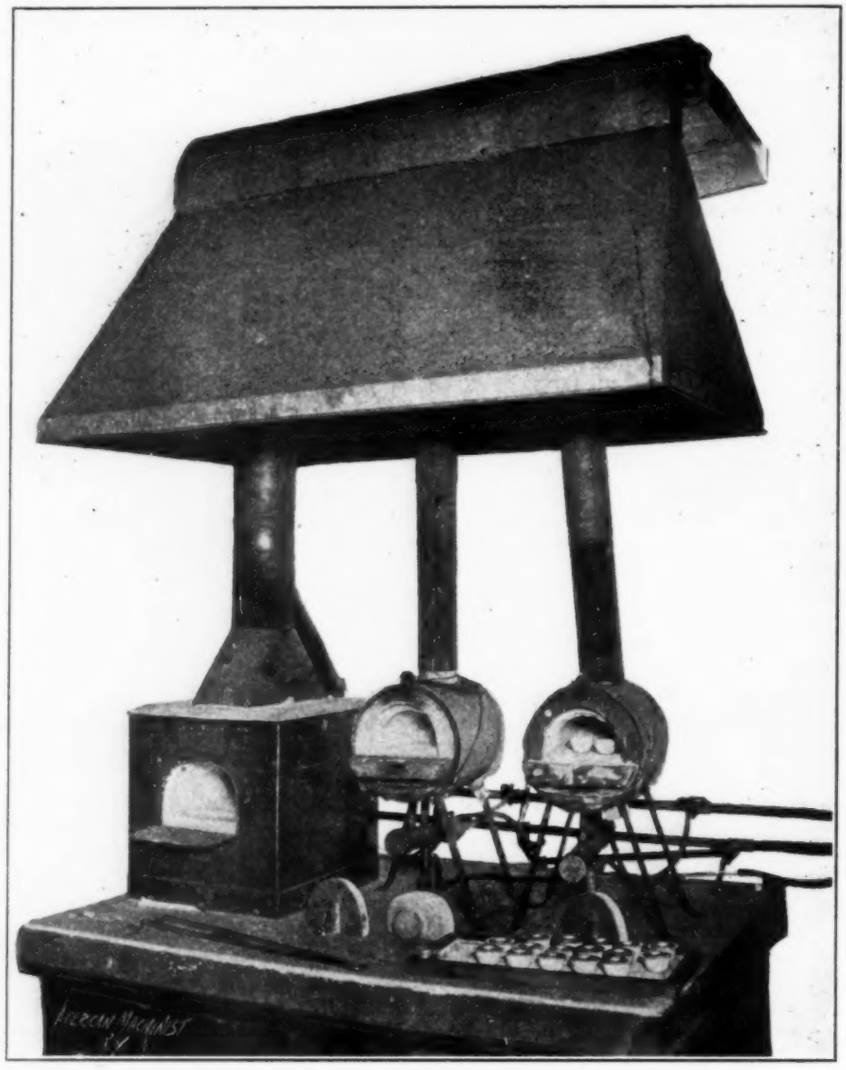


FIG. 1. MUFFLE FURNACES USED TO DETERMINE ASH IN COAL.

In sampling single carload lots approximately 100 pounds are secured, and this is crushed to a size not exceeding ½ inch in diameter, and is then thoroughly mixed, after which the coal is quartered, alternate quarters being discarded. The coal is again mixed and the same procedure followed until the sample is reduced to a 2-pound quantity. It is then placed in an air-tight receptacle, sealed and forwarded to the laboratory for analysis. In shipments of large amounts samples are not secured from every car, but from every second, third or fourth car, depending on the size of the shipment.

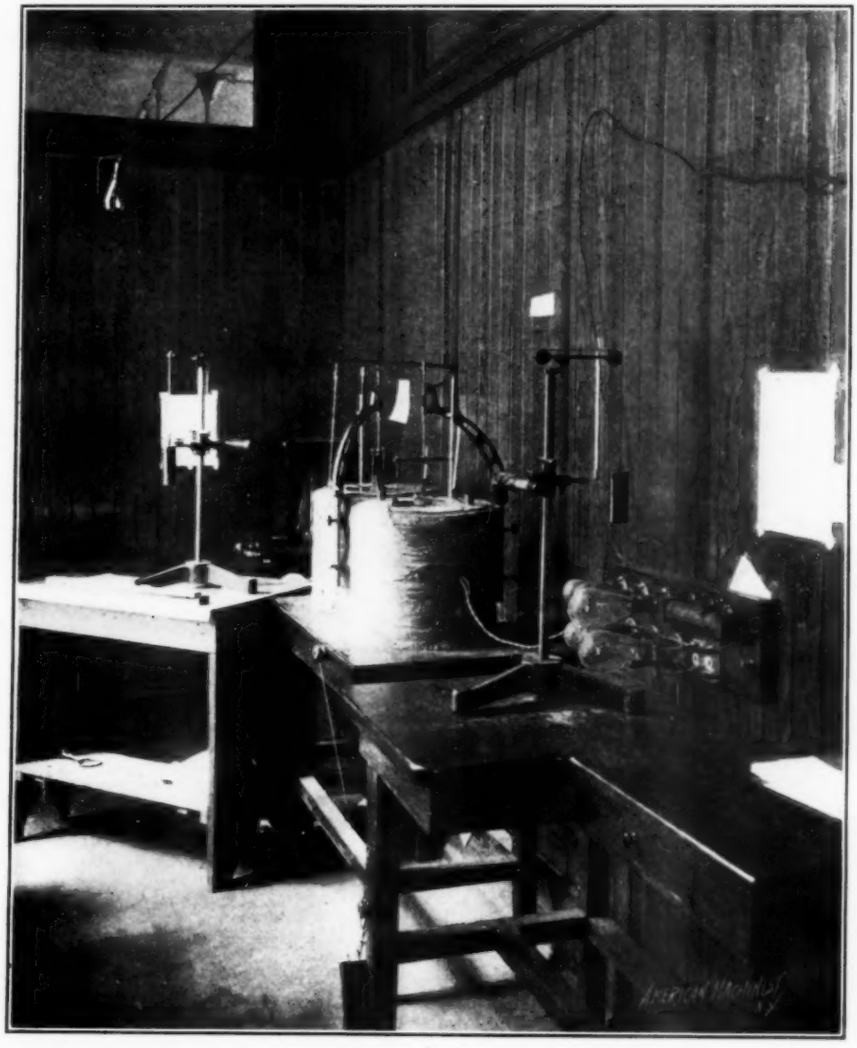


FIG 2. CALORIMETERS USED IN OBTAINING HEATING VALUE OF COAL

In securing samples of coal loaded on board steamships the same procedure is followed, and in quantities up to 5000 tons the method is to sample every third car. In a cargo of several thousand tons the number of samples taken varies as the amount of the tonnage. The determinations of the separate samples are averaged and are taken as representative of the carload.

In taking samples of coal in barges the same method applies as in securing samples from the tops of carload lots. This sample is probably more representative, as the coal has not been subjected to the jarring effect due to train transit. Wherever possible, however, samples are taken as the barge is unloaded. The number of samples taken depends entirely on the amount of coal in the barge.

In cases of sampling involving frequent and large tonnages the inspector after he has crushed the sample to ½-inch size, passes the same over a ½-inch riffle, which divides the sample into two equal parts. One of these parts is discarded and the remaining one is put through a riffle. This procedure continues until the sample is reduced to a size suitable to place in air-tight mailing receptacles. The apparatus consists of the riffle or mechanical sampler and two buckets. One bucket is used to pass the coal through the sampler, and the other placed under the sampler and catches the portion of the coal which is from the calorimeter, in order that there may be no errors due to heat radiated from the observer's body.

A known weight of the sample of coal to be tested is placed in the bomb in contact with a very fine fuse wire, preferably of platinum. The bomb is then charged with pure oxygen gas at a pressure of about 20 atmospheres, 300 pounds, and is immersed in the known weight of water. The water is agitated by a suitable stirring device to maintain a constant temperature throughout its entire volume. Readings of the thermometer are then made at stated intervals of time until the variations in temperature are constant. The charge in the bomb is then ignited by means of an electric current which heats the fine fuse wire to redness.

The combustion thus caused is actually an explosion and is so intense and instantaneous that the platinum fuse wire is melted. The actual time consumed for the combustion is only a fraction of a second. Thermometer readings are made at stated intervals of time until the maximum temperature is recorded. Suitable corrections are allowed for, and then knowing the weight of the sample used, the weight of the water about the bomb, the water equivalent of the bomb and the actual rise in temperature, the calories, or British thermal units in the sample are calculated.

Fig. 2 shows two of the bomb calorimeters used by the technologic branch of the United States Geological Survey. To indicate how these are actually used and to supplement the very brief general description of the calorimeter and its use, we quote at some length from a professional paper of S. S. Voorhees, testing engineer of the technologic branch.

"The apparatus consists of an outer jacket containing water, insulated by a layer of curled hair held in place by an outside leather covering. The water is not changed and assumes the temperature of the room. Its temperature is read by a thermometer graduated to the 10th part of a degree Centigrade. The inner vessel holds the water surrounding the bomb. It is insulated from the outer water jacket by a 2-inch air space and a cork and hard-rubber stand on the bottom. The temperature changes due to combustion are read by a very accurate thermometer, with a range of 12 degrees graduated to the 100th of a degree Centigrade. With a small telescope readings are readily made to the 1000th part of a degree Centigrade. The bomb itself is made from a special aluminum bronze, heavily plated with gold on the inside and nickel-plated on the outside. It contains 3029 grams of aluminum bronze, 578 brass, 77 gold, 4.5 platinum, 6.5 steel, 2.4 insulating material, making a total of 4509 grams, and having a water equivalent of 478 grams.

"A small pin is connected with a platinum plug extending through and insulated from the bomb by fine asbestos paper. The platinum stand which supports the crucible in which the coal is fired is made in two parts, insulated from each other by a plate of mica. A very fine platinum wire 0.004 inch diameter is formed into a loop in the crucible and

bridges the insulation in the support. The circuit is now complete from this insulated binding post on the jacket through this pin to the platinum plug to which the support is connected, through the platinum fuse wire to the bottom of the bomb, and finally through the jacket and out. A small motor drives the stirring device which can be turned in so as to mix the water in the outer jacket, as well as in the bath about the bomb.

"The bomb is held in a clamp while being charged with oxygen, and is closed with a lock nut, which presses down the lid on a pure tin gasket. A simple check valve (a brass piston which seats a rubber washer when pressure from the oxygen tank is reduced) prevents any material escape of oxygen until the cap is screwed down. The oxygen is supplied from a cylinder holding 100 gallons under some 1200 pounds pressure. Now, to make the determination the stirrer is started in the outer water jacket and run for some 15 minutes, with a thermometer inserted to determine the temperature of the jacket.

"A little more than 1 gram of the pulverized coal is weighed and compressed into a tablet in the diamond mortar by a hand-power screw press. This tablet is accurately weighed to 0.1 milligram (0.0001 gram) and placed in contact with the platinum fuse wire in the crucible and with the support inserted in the bomb, and the bomb is closed and charged with oxygen until the pressure gage shows about 350 pounds. It is then placed in a jacket and immersed in 1500 grams of water, cooled to a temperature of about 5 degrees Centigrade below that of the outer jacket, so that the final temperature will be within a fraction of a degree of the outer jacket. The stirrer is started and the temperature readings made at half-minute intervals until the change is constant, usually about 0.01 degree per minute.

"The circuit is closed by a switch, an ammeter reading is taken and the initial temperature is recorded. The readings are now taken at ¼-minute intervals, and the rise in temperature is very rapid. By the end of the first minute the temperature is usually within ½ degree of the maximum. The readings are continued for about eight minutes after firing until the temperature changes become constant, showing that the maximum temperature has been recorded.

"If, as in a normal bituminous coal, desired for the ultimate sample. The buckets are interchanged until the last portion divided gives the quantity desired."

A sampler similar to the above is used for the quartering or dividing work in the coal-crushing room and laboratory. By the use of this apparatus the personal equation is more or less eliminated in securing the final sample from the gross sample. The essential feature is to procure a sample that shall be representative of the entire lot of coal to which the results of the analysis of the sample are to be applied. As outlined, the procedure is to take a comparatively large sample from the carloads or cargoes as the case may be, eliminating as far as possible all factors which will tend to give too rich or too lean a sample; then by suitable mixing and subdividing a final small sample is obtained, which shall be as representative of the large sample as the large sample is of the entire amount.

It is necessary that the entire process of sampling be carried on as rapidly as possible to prevent moisture changes due to the effect of exposure to the air. This is especially important if the coal is bought on an "as received" basis. In most cases there will be a loss in moisture in obtaining and preparing a sample for analysis which will be in favor of the seller. To care for the changes occurring in the laboratory the sample as it is received is crushed as rapidly as possible so as to pass a ¼-inch mesh sieve. A large sample of this crushed coal is exposed to atmospheric conditions in the laboratory until it reaches constant weight. This coal is called "air-dried." On account of the difficulty of handling this large sample it is the more general practice to take a smaller sample of this crushed coal and dry it in an oven at 105 degrees Centigrade to constant weight. This gives a "dry coal" and "total moisture."

Another portion of this coarsely crushed sample is sampled down and ground so as to pass a 60-mesh sieve. This finely ground sample is used for the proximate analysis and the determination of heat values. From these two moisture determinations the proximate analyses and heat values are calculated to the "as received" and "dry coal" basis.

Another point which should be considered is the change in moisture in the coal due to drying after it is mined, in transit, storage, and the like. We quote: "The coal as it is mined contains a normal amount of moisture which varies from less than 2 per cent. in some of the Eastern coals to as high as 30 to 40 per cent. in some of the Western lignites. This moisture content changes as the coal is exposed to the air, in transit, or in storage, so the ash, volatile matter, fixed carbon, sulphur, and British thermal units are increased as the coal dries out and diminish as the coal takes up moisture. This fact is of especial importance to the user who desires to know the actual value of the coal as it is received. If, however, the sample is taken when the shipment is weighed any increase in moisture content above normal will increase the tonnage to exactly compensate for the diminished heat value of the coal. Therefore, if the coal is bought and paid for on a strictly *pro rata* heat-unit basis the increased weight balances the decreased British thermal units in the coal as received."

Methods of Analysis

The coal analysis, as conducted for the United States Government in connection with the adjustment of price on coal contracts involves a determination of the moisture, ash, volatile matter, sulphur and the heating value in British thermal units. From this analysis the price paid for the coal is adjusted in accordance with the price bid. To the average consumer, however, a much simpler procedure will undoubtedly afford adequate protection. This simpler procedure involves merely a determination of the ash and heat units, on which basis a correction can be made in adjusting payment. For this reason we will only consider the methods used at the technologic branch for determining the percentage of ash and the heating value of the coal.

Turning to the illustrations, Fig. 1 shows a group of muffle furnaces for determining the percentage of ash, and Fig. 2 a pair of bomb calorimeters used for determining the number of British thermal units, or the heating value.

The percentage of ash or mineral residue of a sample of coal is obtained by completely igniting or burning all of the combustible matter in small, gas-fired, muffle furnaces, the sample being contained in a desiccating dish, see Fig. 1. As used in Government specifications the percentage of ash is calculated to dry coal; that is, coal from which all moisture has been driven. The moisture is driven off by heating the sample to 105 degrees Centigrade for one hour in a ventilated oven supplied with dry air.

The direct method of determining the heat values of a specimen of coal is based on actual measurement of the heat produced by combustion. With apparatus of proper design, and with suitable precautions and corrections, this method gives the most accurate results that it is possible to attain; in fact, it is used as a standard to determine the accuracy of all other methods. The instrument used is what is known as a bomb calorimeter, a metallic vessel or bomb made from a high-carbon steel and so designed that it can withstand an internal pressure of 300 atmospheres, or say, 4500 pounds. The inside of this bomb is lined with some metal to prevent corrosion from the resulting gases, and is surrounded by a known weight of water. The vessel containing this water is insulated by an air space, and this air space in turn is surrounded by a jacket of water which is kept at the temperature of the room. The outside of the water jacket is insulated by a layer of felt, or other suitable insulating covering. The temperature measurements are made by a special thermometer, which is very sensitive and accurately graduated to read to the one hundredth part of a degree Centigrade. The readings are taken by means of a telescope at some distance. 1.0053 grams of sample were used, and the corrected rise in temperature was

4.176 degrees, the water used being 1500 grams plus 474 grams for the water equivalent of the bomb, we have

$$1974 \times 4.176 \div 1.0053 = 8202$$

calories, and multiplying these by 1.8 = 14,764 British thermal units."

"Such is the method used to determine the British thermal units in a sample of coal. These determinations are always made in duplicate, and are required to agree within 40 British thermal units, or less than 0.3 of 1 per cent. By this method the heat imparted by a given amount of coal to a given amount of water is actually measured. Thus a British thermal unit becomes a real thing, and when one stops to realize the amount of stored energy in the coal and notes how much heat it yields, he is amazed. Take a single gram of coal. When this burns it raises the temperature of 8202 grams of water 1 degree, or putting it in another way, 1 pound of this coal will raise the temperature of 82 pounds of water from the freezing point to the boiling temperature. Or, in still another way, 1 pound of such a coal will actually develop 1 horsepower for one hour."

Minimum Yearly Tonnage to Which Specifications can be Applied

The question is sometimes asked—what is the smallest yearly tonnage for which it is economical to prepare specifications on a heat-unit basis and to take the necessary steps to see that such specifications are properly carried out? Such minimum yearly tonnage is a variable amount and depends in part upon the following: The rate at which coal is delivered, the facilities at hand for making heat value determinations, and the character of the coals which compete in the particular market in question. In cases in which the consumer has not the facilities at hand for making determinations, but has to depend upon a commercial laboratory, the minimum purchase per annum to which it would be economical to apply such specifications is probably in the neighborhood of 1000 tons.

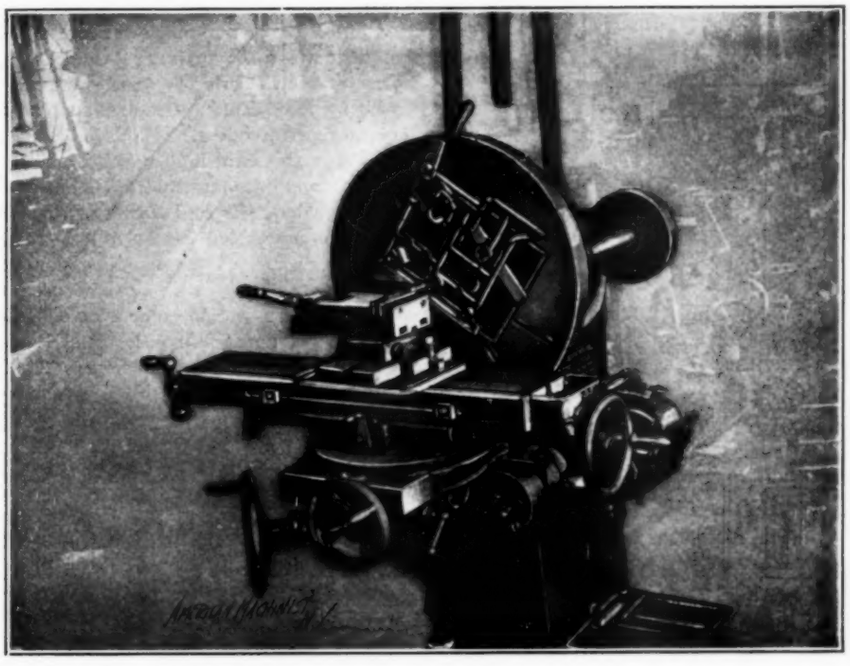
Boring a Large Jig on a Milling Machine

A somewhat unusual use of a universal milling machine is shown in the accompanying illustration, which shows a face-plate job, too large for any lathe in the shop, being done on a milling machine.

A large face plate was made to fit the milling-machine spindle, and to this the work, fastened to the master plate, was clamped for boring. A master plate was first made and the holes to be bored, carefully laid out on the master plate and used as a guide for boring the work itself.

A carefully turned centering stud was put in the milling-machine spindle, which fitted the holes bored in the master plate, and the work located from this. In this way the master plate, and with it the work to be bored, can be shifted from hole to hole, while the work can be bored to any desired size at each point by the tool held in the vise of the milling machine, as shown.

A milling machine can be given quite a large capacity for work of this kind by lowering the knee and this suggestion ought to be of value in many tool rooms. It was worked out by E. A. Oakes, now superintendent of the Seneca Falls Manufacturing Company, to whom we are indebted for the information and illustration.



BORING A LARGE JIG ON A MILLING MACHINE

A Pneumatic Repair Table

By W. H. Snyder

Fig. 1 shows the table in a vertical position with a pump ready to be bolted to it. The table pivots on a central leg, which is the piston of an air cylinder sunk in the floor. To the right in Fig. 1 can be seen a diagonal rod. One end of this rod is pivoted to the end of the table, while the other end is pivoted in an eye bolt in the floor. When the pump is secured to the table the air is turned on, the piston ascends and the rod at the end of the table draws it to a horizontal position with the pump in good position for repairing. When the table is in a horizontal position, it is locked, the rod at the end is removed and the pump and table can be swung around so as to secure the best light for working. In our shop where we have large numbers of air pumps to repair, this is a very handy device.

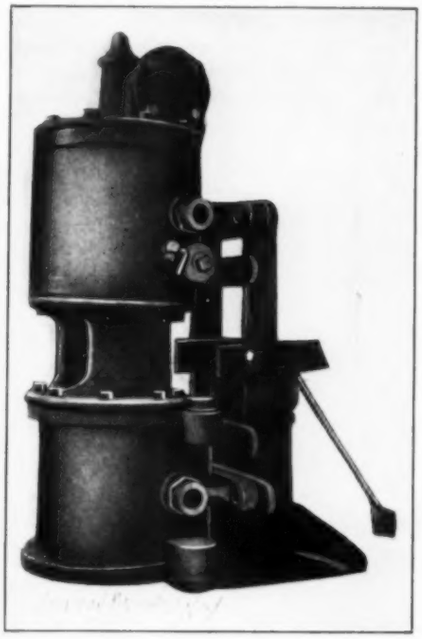


FIG. 1. TABLE AND PUMP IN VERTICAL POSITION

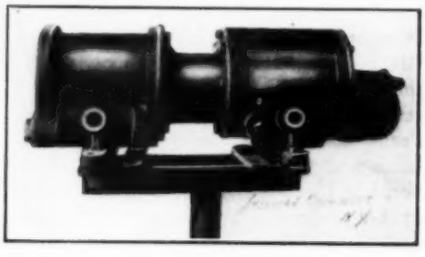


FIG. 2. TABLE AND PUMP IN WORKING POSITION

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Lapping Micrometer Anvils

Various methods of truing the anvils of micrometers have been shown in the AMERICAN MACHINIST, but what in my opinion is the simplest and most effective method has not been discussed.

For "doing up" my micrometers I keep always by me two laps of tool steel about 1 inch long and ¼ inch wide. No. 1 lap is 0.0625, and No. 2 lap 0.050 inch thick, and they are as flat and parallel as it is possible to make them. Whenever I *imagine* that the anvils need truing up, long before inaccuracy can be detected by measurement or the application of the knife-edge straight-edge, I start in to true them up by the following method:

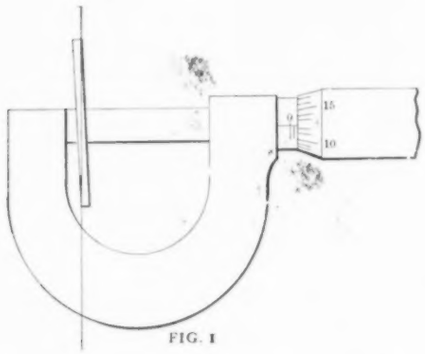


FIG. 1

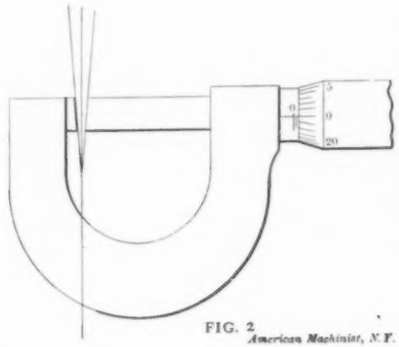


FIG. 2

American Machinist, N.Y.

LAPPING MICROMETER ANVILS

Coating both sides of No. 1 lap with a little rouge and oil and closing the micrometer anvils on the lap with very slight pressure, I rub the lap to and fro between them for a few minutes. After cleaning, the anvils show a high polish all over, but the plane of their surfaces may not be perpendicular to the center line passing through the screw and fixed anvil. If they are not true in this respect the error will show (enlarged twice) when the micrometer is closed, because the screw, as regards angular position, is half a turn from the position in which the anvils were trued up to one another. In other words, the high points are on the same side of the center line, and will be so when the anvils are closed on No. 2 lap. The line sketches (exaggerated) show this clearly. I next coat No. 2 lap on both sides with rouge and proceed as with No. 1 lap. As a rule, the anvils will then be flat and the faces parallel to one another for every position of the screw, but if in doubt I go over them again with No. 1 lap, for the high points are on the same side of the center line for that size now.

This principle can be carried on indefinitely and in theory absolute accuracy obtained. The method has the advantage that the anvils can be kept in good condition all the time with little labor, and without expensive tools. Moreover, the smooth finish and high polish resulting from the use of rouge minimizes wear and reduces the tendency to hold dirt.

If the anvils are worn badly it is advisable to use two laps charged with diamond for roughing down, another set with emery or carborundum for smoothing, and a third set with rouge for finishing. It is remarkable how quickly very badly worn anvils can be trued up with two diamond-charged laps.

The above method is only applicable to 1-inch micrometers, but it is seldom that the larger micrometers are required to measure on the edges of the anvils, and I prefer them with faces slightly spherical.

New York City. F. J. B.

Forming and Assembling Punch and Die

In the accompanying illustrations will be seen a punch and die for forming and assembling a card-holder leaf for the Hammond typewriter. These tools are used on a single-action power press at the Hammond Typewriter Company's works in New York City and were designed by J. A. Ruffin, vice-president and general superintendent.

In Fig. 1 this card-holder leaf is shown in detail and also assembled. The material it is made from is but 0.018 thick and when assembled forms a leaf 10½ inches long; to facilitate handling during assembling as well as in general use it is made in two sections, one of which is shown in the upper half of Fig. 1. Each of these sections has nine fingers *A A*, which are 13/16 inch long and to stiffen them a rib is formed through the center. On the opposite end of every other finger there are two short extensions which are forced automatically in the press around a small shaft as shown in Fig. 1. This job, like many others, had its difficulties and was only accomplished after experimenting. The most serious trouble met with was in keeping the fingers all in line

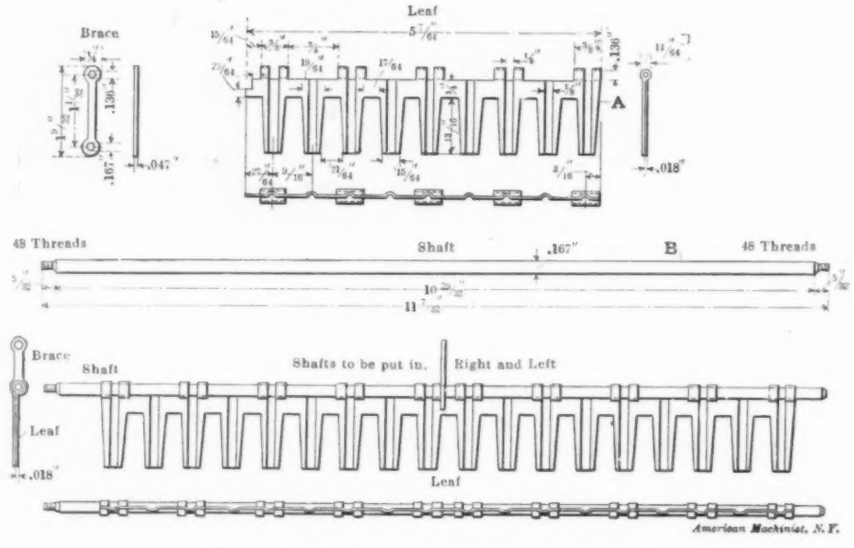
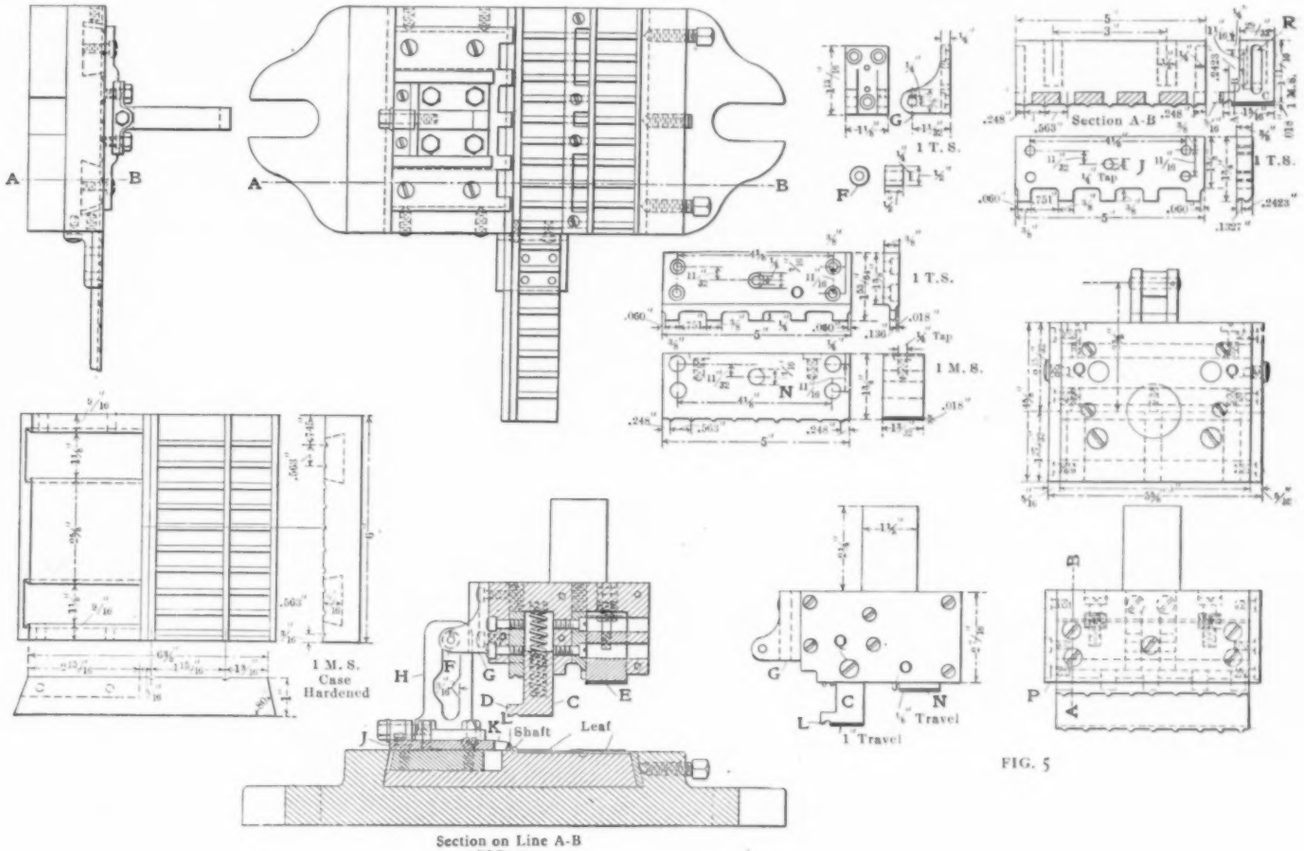


FIG 1. DETAILS OF TYPEWRITER CARD HOLDER

with one another. This might appear a rather simple problem and it may be thought that if the dies and formers were straight the job would be straight; and so it would, but in the course of handling from one position to another the work slipped on the shaft and came out in all directions, as it was impossible for the former and die to fix it so tight on the shaft as to enable it to stand all abuse. This difficulty was finally overcome by prick punching the shaft at points where the material was to surround it; the thin material would then enter these spots when under pressure, thus preventing the fingers from turning around, and to make them still more secure they were later soldered.

In Fig. 2 will be seen the forming punch and die. In the plan and side view to the left only the bottom member is shown, while in the vertical section both top and bottom tools are shown along line *A B* of Fig. 2. The card leaf can also be seen in place in its two shapes just as it is before the top tool comes down. When the top member does come down as shown in Figs. 3 and 4, the spring finger or holder is the first to come in contact with the material. This finger, which is better shown in detail in Fig. 5, has four side extensions *D* with semicircular grooves running across the face for receiving the semicircular beads meshing into the grooves of the material. The moment the finger *C* has come into firm contact with the material, a roll *F*, which is held in the small casting *G* and which works in the groove in the cam bracket *H*, has reached a position where it commences to travel over the raised surface on the face of the cam groove and the cam bracket is made to slide toward the center of the machine. Attached to this cam bracket *H* is a finished tool-steel slide *J* which has on one end five fingers specially shaped to fit the shaft and so placed as to come in contact with the turned-up ends *L* of the leaf and turn it over the center of the shaft as the slide is pushed forward by the roll in the cam bracket as shown in Fig. 3. The total throw of this slide is 3/16 inch, which is the hight of the raised section of the cam bracket. After the roll reaches the top of the high point in long shaft and holding it in position. The locating device is not shown but consists of a stop on the side of the baseplate, and during the locating a small brace (see Fig. 1) is slipped on the shaft and finds a bearing in a slot made in the base. The finger *C* is so placed as to come in between the turned-up ends of the leaf, and while the extension *D* holds the shaft the main section of *C* holds the material as well as locates it by the aid of the nine



Section on Line A-B
FIG. 2

FIG. 5

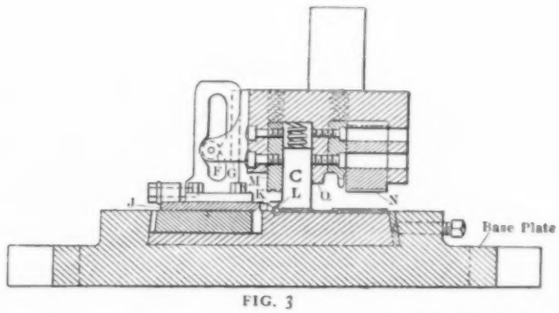


FIG. 3

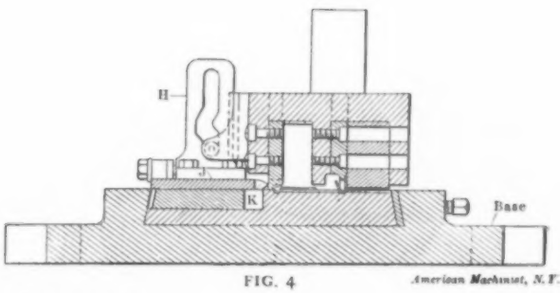


FIG. 4

American Machinist, N.Y.

PRESS TOOLS FOR TYPEWRITER CARD HOLDER

the groove it travels down over the slope, pulling the finger *J* back to its former position so that the finger *K* is clear of the former and punch *M* above it. It will be observed that the finger *C* has moved up slightly within the holder against spring pressure; it is this spring that forces the material which is being worked down tight in the form below, while *K* and *M* do their work, and while these two are operating, the two formers *N* and *O* come down against a piece of flat material and put it into shape for the next operation. Thus after the first operation a complete leaf is made and formed on one end of the shaft and by turning the shaft around another leaf is formed on the opposite end, producing a finished assembled leaf as shown in Fig. 1.

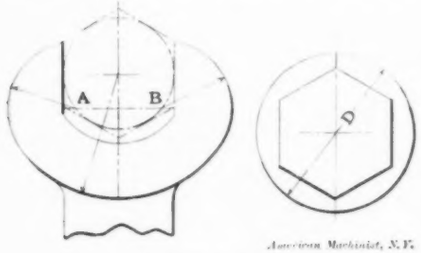
New York City. JAMES P. QUINN.

Room Required for Wrenches

When designing machinery of any description it is necessary to see that sufficient room is left for using a wrench on all nuts so that when erecting or dismantling no difficulties shall be encountered on this score.

One method frequently used to determine how much room it is necessary to leave for claw-wrench clearance is to draw out on tracing paper or cloth a set of claw wrenches to each of the usual scales; that is, full, half, quarter size, etc. These are then cut out so that they can be laid on any drawing which is being made, from which it can be seen that it is quite easy to see if sufficient room is being allowed.

The only drawback to this method is that the piece of paper on which is drawn the wrench required is generally



ROOM REQUIRED FOR WRENCHES

missing. A far simpler method is to remember the usual proportions of claw wrenches which are as shown in Fig. 1, which is practically self-explanatory; for if the two farthest points of any two adjacent sides of a hexagon be joined by a line then the claw-wrench head to suit this hexagon can be drawn in as follows: With centers *A* and *B*, where the aforesaid line cuts the inscribed circle and radius to the ends of the next adjacent sides describe two parts of circles, then from the center of the hexagon describe part of circle, joining the two aforesaid parts of circle, and the claw-wrench head is complete, so that it is quite simple to lightly draw in the wrench head when making drawings and thus insure sufficient room being left.

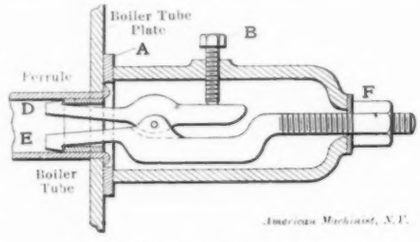
For box wrenches it is only necessary to remember that the outside diameter of the box *D*, Fig. 2, is usually $2d + \frac{3}{8}$ inch, when d = diameter of bolt, and thus it is quite simple to allow for this.

London, England. SILENT.

A Good Ferrule Extractor

The boiler-tube ferrule extractor illustrated herewith is being used in a number of locomotive shops and has the advantage over many of being cheaper and easier to construct; of being "huskier," to stand more abuse and having the advantage of being capable of some adjustment for use in various sizes of boiler tubes.

In using the ferrule extractor shown in sketch, a hard-steel washer *A*, is first placed against the tube plate, the set screw *B* being slackened to allow the jaws *D E* to enter. When all are in position, the set screw *B* is advanced far enough to press the jaws of the extractor tight against the sides of the boiler tube; the



BOILER-TUBE FERRULE EXTRACTOR

nut *F* is then turned with a wrench and the ferrule gradually drawn out.

Poughkeepsie, N. Y. R. P. M.

A Simple Automatic Drill Chuck

Where it is necessary to change drills several times on one piece of work, or where drills often require sharpening, the constant chucking and unchucking becomes very tiresome and a source of considerable expense.

Where there is work enough of this kind to make it pay to make a set of drills with one size of shank, a drill chuck like the one shown in the sketch will prove profitable, for while it is very simple and inexpensive to make, it has several advantages over ordinary chucks, and will wear well.

With this chuck you can chuck or unchuck a drill with very little effort, though it will twist the drill in two every time rather than slip, and as no part of the chuck is sprung while in use or subject to strain, it will always hold the drill absolutely true if the drill shank fits the hole. The shank can be either taper or straight. It can be made of much smaller diameter for the size of drill it will hold than any other chuck; it would, therefore, prove valuable for use on gang drills where the holes are to be drilled close together. As the chucking and unchucking is done by a motion parallel with the axis of the drill and requires almost no effort, it can be used in a space just large enough to allow it to turn freely.

The balls are the parts of the chuck most likely to wear if the shell and body are properly tempered, and they can always be replaced so easily and cheaply

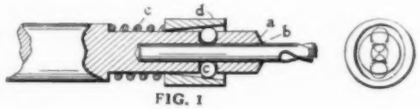


FIG. 1

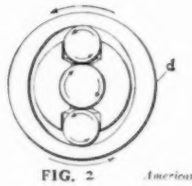


FIG. 2 American Machinist, N.Y.

A SIMPLE AUTOMATIC DRILL CHUCK

that the chuck can almost be said to be indestructible.

Fig. 1 shows a cross-section through the assembled chuck and an end view. Fig. 2 explains its operation and why it grips the drill.

The body of the chuck shown at *a*, Fig. 1, is preferably made of tool steel and hardened. The hole *b* must be straight and true and the transverse hole *c* reasonably central.

The hole *c* is first drilled through with a drill about half the size of the balls to be used, and afterward countersunk with a larger drill to form the ball pockets; this construction preventing the sleeve *d* from dropping clear off when no drill is between the balls, and also keeping the balls from dropping out through the hole *b*.

The sleeve *d* is tapered inside and the front end can be pressed in a vise to give the hole an approximately elliptical shape, after which it can be turned on the outside to make it round if desired. It must be hardened.

The helical spring *e* can be very weak, as it is merely intended to press the balls into contact with the drill by means of sleeve *d*.

In Fig. 2 the balls are shown in their normal position across the largest diameter of the elliptical hole with the sleeve in contact with them, and the drill between them, and by means of the arrows it can be seen how attempted slipping of the drill will roll the balls and cramp them between the shortening diameter of sleeve *d*.

The taper in sleeve *d* should be about $2\frac{1}{2}$ degrees on a side before pressing the end out of round; more than that causes the sleeve to back up as the drill binds, and less makes unchucking rather more difficult.

Elgin, Ill. HERBERT L. THOMPSON.

Internal Threading Tools

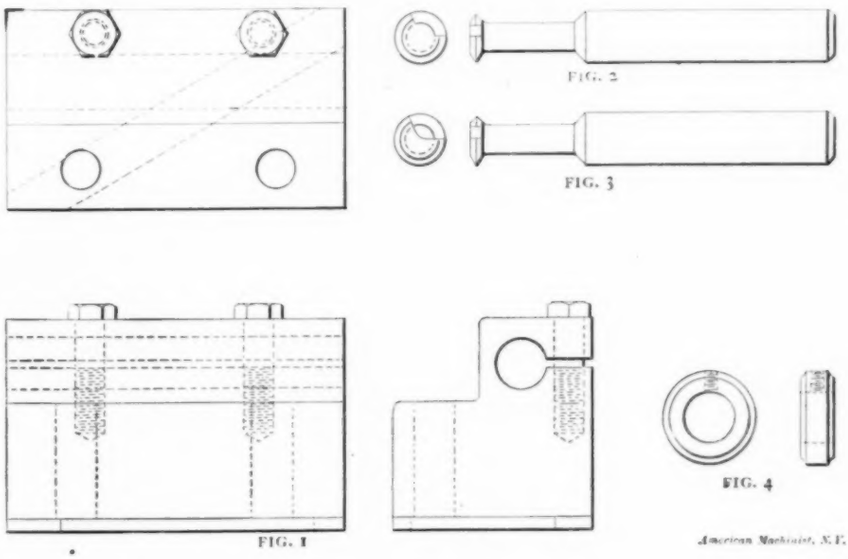
Although a great deal of valuable information regarding threading and threading tools has appeared in these columns in the past, perhaps a few remarks as to the practice of one prominent concern will be of interest to your readers.

Much difficulty was experienced in the threading of female gages of the larger sizes and the following description will show how some of these difficulties were overcome.

Fig. 1 is a sketch of the holder for the thread tool. This holder is made of cast iron, with a tongue planed on the bottom at an angle of 29 degrees as shown and fitted to the top slide of the compound rest of the lathe. It has a ¾-inch hole bored through at the proper distance from the bottom, so as to bring the center line of the tool at the center line of the lathe spindle, and is slotted on the front side and tapped for two hexagon head screws, thus providing means for binding the tool in position.

In the roughing out of gages of comparative coarseness of thread, there are used two tools, a roughing tool and a finishing tool, the former shown in Fig. 2 and the latter as Fig. 3. Perhaps few mechanics, other than those actively engaged in this work, can realize the rapidity with which the stock can be removed with the roughing tool shown. In the roughing out of the work the tool is fed into the work by means of the compound rest swiveled at an angle of 29 degrees, and therefore the cutting is done mostly on one side, and this must be the leading side in order to give a shearing cut to the tool. When the roughing out is accomplished, the tool is removed and the finishing tool inserted, the finishing of the work being accomplished by feeding into the cut at right angles to the axis of the work, and not by the use of the compound rest as in roughing.

In order to remove the tool for sharpening and also to permit returning it to its original position, use is made of a stop collar as shown in Fig. 4, which is allowed to remain on the tool until the conclusion of the threading operation.



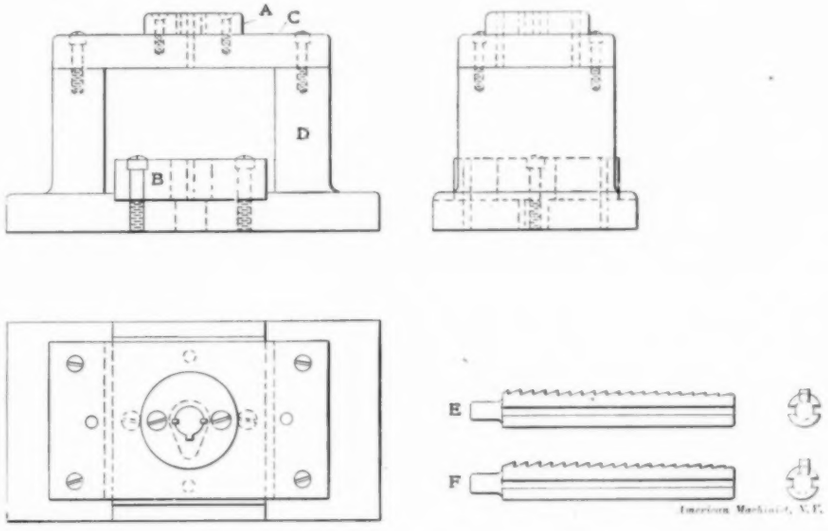
INTERNAL THREADING TOOLS

Much thought was given to the subject of the tools, of which it is necessary to make quite a stock for the various diameters of work, but the form shown in Fig. 3 gives every satisfaction and will produce a practically accurate thread if the proper attention is given to the making of it.

Chicopee, Mass. A. K. GUILD.

A Broaching Fixture for Cams

The accompanying cut shows a fixture designed for broaching keyways through cams used on gasolene motors. The object sought and accomplished was the location of the keyway in correct relation to the raise of the cam. This fixture has been in use some little time and broached possibly two thousand pieces with unvarying accuracy, proving that it simplifies and cheapens this particular operation compared with the former way of doing it, by means of a shaper and ordinary keyway tool, although the principal point in view at the start was duplication.



A BROACHING FIXTURE FOR CUTTING KEYWAYS IN CAMS

The base *D*, is a gray-iron casting machined on bottom and top of uprights, also in the wide slot between the uprights, in which is located by screws and dowels, the position plate *B*, which locates the cam for the machining. These plates, two in number, one each for inlet and exhaust, were made of machine steel case hardened and very carefully brought to size. They also serve as gages in the milling operation which precedes this one.

The crosspiece *C*, has a steel plate *A* screwed and doweled to it which the broach slides through, the two inserted feathers sliding in grooves milled in the sides of the broaches. This gives a positive location for keyway.

The broaches *E* and *F* are each eight inches long, case-hardened, straightened and ground. The cutters are doweled and screwed into them. The hole in the cam is 0.875 inch. The size of the keyway is ⅛x¼ inch. Each tooth of the broach removes a little over 0.002 inch of metal.

E broach in going through, takes out a trifle over 1/16 inch, leaving not quite as much more for the last one *F*, thereby giving a very satisfactory finish.

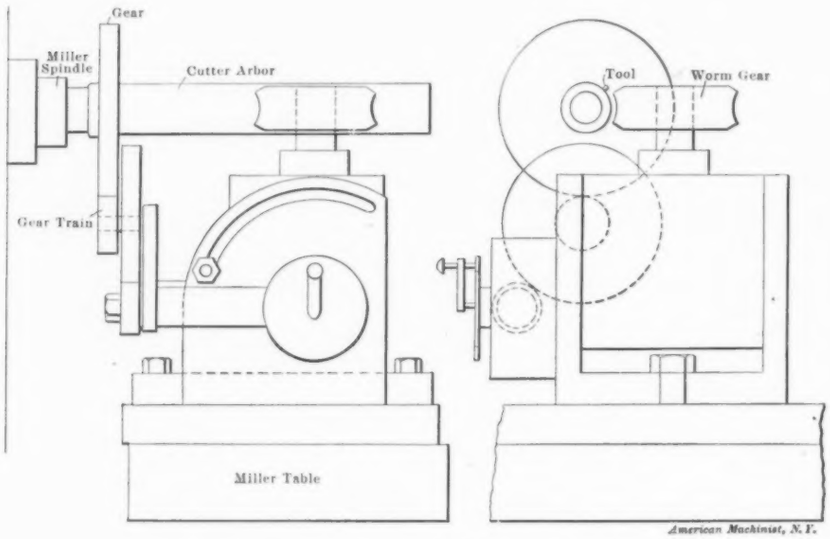
This may suggest to some of your readers many more jobs of a like nature which could be done in the same way with better results.

It will be seen at a glance to be simple in design and the cost of making very low.

Cleveland, Ohio. A. DANE.

Cutting a Worm Gear without a Hob

We recently broke a worm gear which operates the feed on a milling machine.



CUTTING A WORM GEAR WITHOUT A HOB

As the machine was arranged for special work which we needed badly, we had to replace it as quickly as possible. It was a 36-tooth gear driven by a worm 1 15/16 inches in diameter with a multiple thread. The steepness of the pitch made anything but a hobbed gear impracticable; and as we had no hob and did not wish to make one for one gear, we decided to try cutting it on the universal milling machine.

After the blank had been turned and nicked, it was mounted on a mandrel fitted to the dividing head. The dividing head was then raised to a vertical position and placed across the table to bring the spiral shaft, which drives the worm parallel to the milling-machine arbor. A brief consultation of the index plate had shown us that we had the right gears to revolve the blank at the proper speed. As the feed screw was a four-pitch screw, the change gears, which would give a spiral with one turn in nine inches, would, when geared direct to the miller spindle, give one turn of the dividing head to 36 revolutions of the spindle. However, as our worm had five separate threads, we divided this by five and took the gears for 1 4/5 inches which, in this case, were 80, 27, 60 and 24.

The largest gear was placed on the cutter arbor, close to the spindle, and was connected to the worm shaft by the other gears. Care was taken to have the 27-tooth gear as nearly as possible under the arbor in order that the work might be fed to the cutter, which, by the way, was a piece of drill rod about half an inch long, filed to the shape of the thread on the worm, hardened and held in a hole drilled at the joint between two collars. The blank was set at the same hight as the arbor and the cutter set central with the gear blank. It only remained to set the tool to match the nicking and proceed to business. The blank was fed in gradually until the correct depth was reached. In a few minutes after the cutting commenced we had a gear equal to the best. It would be practicable to cut a worm gear in this manner without previous nicking. In our case the results were entirely satisfactory, both as to the quality of the product and the time consumed.

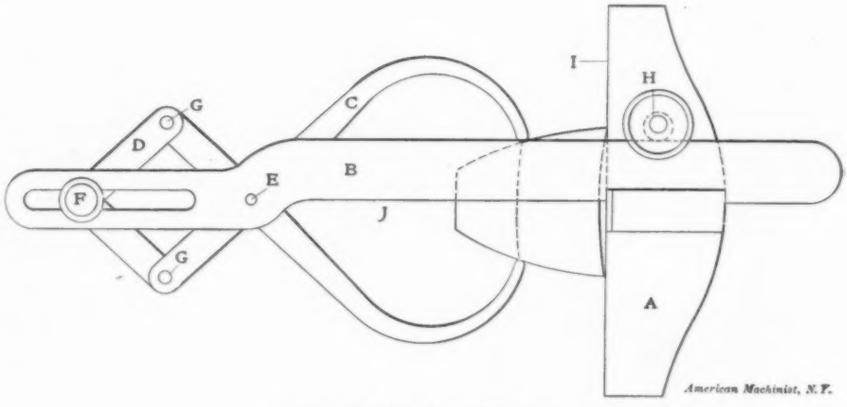
Jackson, Mich. E. S. C.

[This method of cutting a worm wheel is ingenious. It should be pointed out, however, that the single fly cutter cannot produce a tooth of the required form, like that made with a hob, unless the cutter arbor is fed longitudinally past the work to allow the cutter to operate in different positions upon the different teeth of the worm wheel in the same way that the several teeth in the hob do their work. This result could readily be accomplished with the arrangement our correspondent shows, by simply connecting the large gear to the cutter arbor by means of a feather, so that when the dividing head was fed toward or away from the column the large driving gear could slide along on its arbor.—ED.]

A Dividing and Squaring Tool

The accompanying line-cut shows a little tool I have had in use for over ten years, and as I have never seen it described in your columns, nor met any other mechanic possessing one anything like it, trust it may be of interest to others. I made it primarily for squaring the center line on the ends of gear teeth when made in long sticks, or ground out in a former on the turning lathe, by the use of a sand roll. I have found it of equal advantage in dividing and squaring many other different shapes.

The blade *B* carrying the calipers slides in the head *A* held tight by an eccentric clamp *H*. The calipers are adjusted and clamped by the set screw *F*. The surfaces *I* of the head and *J* of the blade are square. The cut shows the outline of a gear tooth in position for dividing and squaring. I set the calipers at the breadth of the tooth and the head is set so that the caliper point will catch the tooth at the pitch line as shown.



A DIVIDING AND SQUARING TOOL

The tool is made of light steel, making it light and easily handled. The calipers are pivoted with a screw at *E*, and the upper piece *D* is riveted at *G*. The clamp screw *F* has flats on the side to fit in slot. All joints are fitted closely and the tool is very accurate in any position where it may be set.

Scottdale, Penn. L. T. COOK.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Expanding Mandrels

In one of the back numbers of the AMERICAN MACHINIST a correspondent gave a description of an expanding mandrel, as shown in Figs. 1 to 4 herewith. This mandrel fits the hole in the lathe spindle and takes the place of the live center. It is used to advantage, where a turret lathe is not available, for turning short bushes, bearings, collars, etc., which have been previously bored.

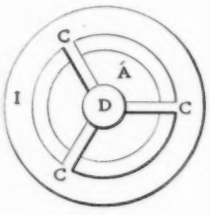


FIG. 1

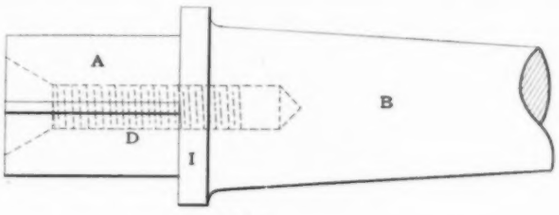


FIG. 2

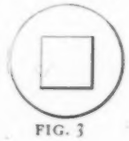


FIG. 3

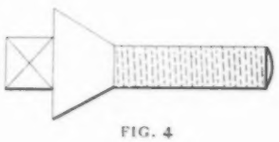


FIG. 4

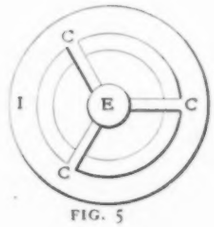


FIG. 5

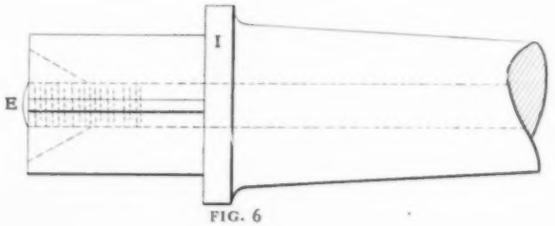


FIG. 6

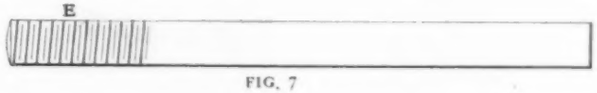


FIG. 7

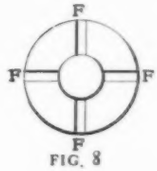


FIG. 8

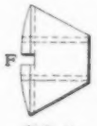


FIG. 9

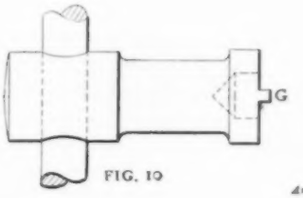


FIG. 10

FIG. 11
American Machinist, N.Y.

EXPANDING MANDRELS

Referring to Figs. 1 and 2, *A* is the business end; *B* fits in the lathe spindle; *C* are three slits 3/32 inch wide milled in *A* up to the collar *I* 120 degrees apart, as shown in Figs. 1 and 5; *D* is a 7/16-inch hole threaded to suit the expanding plug, shown in Figs. 3 and 4, the head being turned to a cone of 60 degrees to fit the end of *A*, expanding it, when screwed tight. After I saw this mandrel in the AMERICAN MACHINIST we made three, and they well repaid us. After a long period, one or two defects developed which we thought it desirable to eliminate in future ones we made. By continually tightening and slackening the expanding screw, Figs. 3 and 4, the thread in the hole *D* became badly worn, with the result that the vibration sometimes slackened the screw. Figs. 5 and 6 show the mandrel as we now make it, and Figs. 7 to 9 show the details. It is rather cheaper to make than the old type, shown at Fig. 1, and gives better results in use. It will be seen that instead of the hole being tapped in *A*, it is bored straight through, as shown in Fig. 6. A piece of bright-drawn steel *E*, shown in Fig. 7, is driven in tight. The nut shown in Figs. 8 and 9, screws on to this stud and expands the mandrel. This nut has two slots milled across at right angles, as shown at *F*. The key, Figs. 10 and 11, is used to tighten the nut, the tongue *G* fitting in the slot *F*. *H* is a ½-inch hole, bored for a depth of 5/16 inch, to clear the end of the stud *E*.

It will thus be seen that there is nothing to project beyond the end of the mandrel *A*, which is an advantage on certain of our work, and the wearing part *E* is easily renewable, should it require it. This gives the mandrel a much longer life and, therefore, cheapens it, which is an important item. The nut and screw are case-hardened, which makes them last a long time.

London, England. J T. CROSLEY.

Mathematics and the American Machinist

On page 172 an editorial appeared entitled, "Mathematics and the AMERICAN MACHINIST," which entirely expressed my ideas regarding the publication of articles and papers involving the use of mathematics. I have been more or less a constant reader of the AMERICAN MACHINIST for the past 10 years, and during that period I have never seen any subject whose treatment involved the use of mathematics, where the mathematics were not of what would be considered a primary character; that is, speaking, of course, from a mathematical standpoint. With but few exceptions, the mathematical treatment of subjects has always been well within the scope of anyone who has had even a grade-school education to start with. Just read those three last words over again, "to start with."

I myself had only a very limited knowledge of mathematics on leaving school at 12 years of age, and I know that, compared with those who have had far greater early advantages, my knowledge of mathematics and algebra would be classed as very elementary. But I early realized the intimate relationship which must necessarily exist between mathematics and mechanics; the early realization of this fact

set me at work in order to overcome the disadvantages under which I labored, and for the past 20 years I have always devoted a certain limited amount of time to the study of mathematics and kindred subjects. In years gone by, even at the present time, there are sometimes subjects treated mathematically in the AMERICAN MACHINIST, and also in other periodicals, which are often, at first, beyond my grasp. At one time I would have passed these things up, but I finally came to the conclusion, that if the subjects treated were things that I really ought to know it was high time that I studied them up thoroughly. Working along these lines has made me go far deeper into certain subjects than I otherwise would, greatly to my own advantage.

What use is a magazine to us if it only tells us the things we know? What we want is something which will tell us and start us thinking and studying about the things we don't know. It is surprising to me how few of even our good mechanics realize the great benefits that accrue from even an elementary knowledge of mathematics, and furthermore, how few realize the fact that this knowledge is comparatively easily acquired.

Somehow when the terms mathematics, algebra, geometry, trigonometry and logarithms are mentioned the ordinary man in the machine shop gets scared, and makes up his mind that these subjects are only comprehensible to the man who has had a college education. In my own case, for a long time I shied at logarithms until it was really forced upon me by circumstances which made it imperative for me to use certain formulas involving their use. I immediately procured an elementary treatise on logarithms, and when I discovered the marvelous simplicity and time-saving qualities of the logarithmic method of figuring I kicked myself good and hard. It is safe to say that not over 1 per cent. of the men who work as ordinary machinists in the majority of our machine shops could tell how to extract the square root of a number, and it is also safe to say that but very few of them could learn how to do it by ordinary arithmetical methods, so as to remember the rule, in much less than a week's study. But if the same men would spend only a few hours in the study of logarithms they would find that by the use of logarithms the extraction of the square, cube, or any root in fact was reduced to a problem in division of the simplest kind.

Trigonometry in its simpler forms should certainly be studied by every machinist and toolmaker, as even the most elementary knowledge of this science must certainly be of the greatest assistance in the solution of many problems which every day confront them. According to my ideas, trigonometry for common, everyday shop use is admirably handled in the AMERICAN MACHINIST handbook, a book which should be in every machinist's hip pocket; it is in every way the biggest $3 worth he can buy. The pages devoted to "shop trig" should be carefully studied by every machinist, and, as far as practical shop work goes, they contain all that he needs. Some may say: "Well! what good is it?"

Let us suppose a case. If you were told to cut an accurate slot in a certain-sized shaft a certain depth and a certain width, you would put it in the milling machine and would fuss and measure the depth on the side of the slot with a scale, and even by the most careful scale measurements it would be impossible to get any nearer to the correct depth than 0.005 or 0.006. Wouldn't it be a great advantage and a saving of time if you knew the exact distance in thousandths or ten thousandths from the outside of the shaft where the cutter first touched to the bottom of the slot? Sure it would. All you would then have to do would be to raise the knee until the cutter just touched the top of the shaft and then, using the micrometer collar on the raising screw, sink the cutter in the correct amount, no measuring nor fussing with a scale and wondering whether you had gone deep enough or gone too far. The figuring out of the above problem is of the simplest kind if you possess even the most elementary knowledge of trigonometry.

One of the most surprising things to me is, that many a young machinist who passes up mathematics as being beyond his powers of comprehension—as being too difficult for him to ever learn—is an expert in other things requiring far more time and application to become proficient in. Take, for instance, the playing of billiards, or pool, at which many of our young men from the machine shops can put up a good game. They are games which require endless practice and a highly developed sense of calculation in order to become even a moderately proficient player, and yet men who have become more than average players at these games will claim that mathematics is beyond them. Practically the same thing holds good in regard to any game, but I have emphasized billiards and pool because they are the games *par excellence* of the calculative skill. I am not against any young man becoming proficient at any game, but I do think that every young man should devote at least some certain portion of his spare time to the study of the things which will make him proficient in his chosen calling. Every young man who aspires to become a good mechanic should study mathematics; without this knowledge, no matter what degree of skill he may attain as a workman, the complete mastery of his profession will never be his. If any young machinist with natural mechanical tendencies will conscientiously devote even a small portion of his spare time to the study of elementary mathematics, he will find that it will help him far more than he ever anticipated; he will find that, as a natural mechanic, mathematics will come to have an absorbing interest for him, and if he perseveres and gradually advances from elementary to higher mathematics, he will find that he is on the straight course toward the highest positions in his profession. Of just such men—men who possess both practical skill and correct theoretical knowledge—are our best and most efficient machine designers made. If you cannot understand the mathematical articles in the AMERICAN MACHINIST, get busy and don't let up until you can. These things are well within the comprehension of every intelligent mechanic if he wants to exert himself. It's up to you.

Rockford, Ill. GEORGE CORMACK, JR.

Grinding Sleeves Internally

At page 986, Part 1, A. B. Trask, in referring to my letter at page 528, says a skilful grinder should grind six sleeves, that is, 12 holes, for less than the cost of a cast-iron bush of the sizes given in the article referred to. This depends on how much he pays for his bush; the labor cost on the one we used was seven pence. Material is still in hand, so the cost of that need not be reckoned. I cannot get 12 holes ground for sevenpence, but the grinding price has been reduced sufficiently to save three halfpence per sleeve, making a saving of ninepence on the six sleeves.

In a self-centering chuck a man may set a job true within 0.005 inch in 20 seconds, or if he has to use cigarette papers he may take five minutes. I cannot say that I have found packing with paper of much use for quick setting; if the self-centering chuck is not true enough for the job, use an independent jaw chuck; 'tis more workmanlike, and saves your cigarette papers.

Mr. Trask also says the proper article to use is a split collet. Now we are getting to expensive tackle; it would take one gross of sleeves to pay for the cost of a chuck and split collet, also with this method the dust gets on the sliding faces of the collet each time it is released to put a fresh sleeve in, and we soon have trouble with the running, and out comes the collet to be cleaned, three or four minutes' job each time. We use self-centering chucks; we have used split collets, but have discarded them for grinding "at present." But, wherever possible, we use a setting bush as described, as they are cheap to make and easy to keep clean and true when in use. My "at present" means I consider that split collets would be very useful for holding small bushes, washers, etc., if they are put through in large quantities, but you must have no face contacts, they must all be points.

Birmingham, England. U. S. GARDE.

English versus American High-speed Steels

Your reprint on page 728, Part 1 of Volume 32, of the article on the newer high-speed steels from *The Engineer*, seems to have (in the phraseology of this district) flicked Mr. Clarage on the raw. On page 1031 he jumps into the arena and leads off with his 1000-pound-per-hour tool, which, by the way, is a moderate estimate for a chip 8400 feet long, 5/16 inch deep and ¼ inch wide. It appears to me that the whole thing hinges on the material used in the various trials, and that one cannot safely make comparisons of brands of tool steel unless they are tried on the same material, and under the same conditions.

We recently had an experience with high-speed steel on cast iron, or at least our foundry people said it was cast iron. There was, however, a doubt in the mind of the foreman machinist, who was rather of the opinion that it was carborundum; anyway, he removed about 6 ounces per hour. The tool used was of English steel, the cast iron also was an English brand.

The latter part of Mr. Clarage's article is all that could be desired, and to toolmakers, like myself, who know little of the metallurgy of the new steels, such an article by a man who evidently knows the A B C of steel making is the best advertisement that the AMERICAN MACHINIST could have, as it shows that it is a practical paper written for practical men.

Woolwich, Eng. W. G. GROOCOCK.

Tang Troubles

The new short shank with heavy tang, adopted by the Standard Tool Company and described in the AMERICAN MACHINIST, I know from experience will solve the problem. From the collection of twisted and tangless drills that one sees it would seem that someone should have done something to prevent this before.

We were using a great many taper-shank bits and many straight-shank bits; with the straight shank we were using what we call a set-screw chuck, the set screw going into a spot on the shank to act as a driver. We were also using these chucks to drive facing bars. The tangs were continually twisting off, making more work for the tool room than seemed necessary, so our tool designer got after it. The drill-press spindles were taken out and rebored to fit a short No. 4 Morse taper with a No. 5 tang, that is, the old tangs were all cut off the chucks and bits at the base and a No. 5 tang milled below.

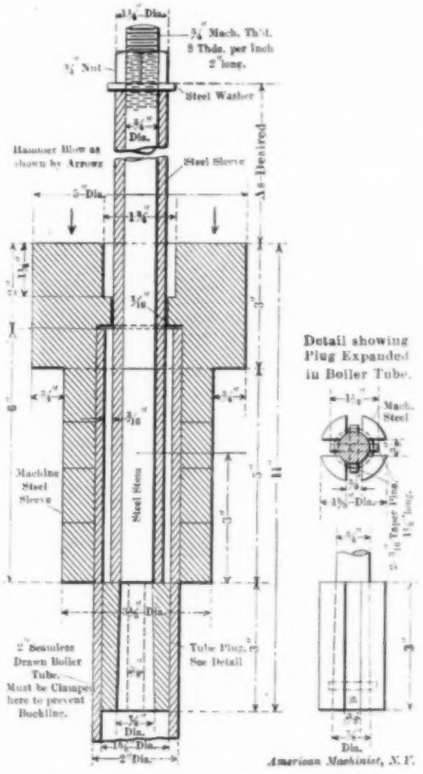
We have been using these for nearly a year and have not broken or twisted a tang. Some of these drill presses have been run 24 hours a day, boring 300 to 400 holes every 10 hours. We also have been facing surfaces up to 3 inches in diameter. It was the facing that caused most of the trouble.

Poughkeepsie, N. Y. MACHINIST.

Upsetting Steel Tube Ends

In your issue of June 24 was a request for a method of upsetting the end of tubes for a distance of 3 inches to a thickness of ⅜ inch.

The tool as shown in the illustration is designed to do this on a 2-inch tube. The tube is held in a clamp, not shown, securely fastened to a bench and on the inside of the clamp, an expanding plug is placed. This plug is tightened by the ¾-inch nut on the front end which pulls the taper end shaft up against the steel sleeve.


¾" Mach. Th'd. 8 Thds. per Inch 2" long.
¾" Nut
Steel Washer
Hammer Blow as shown by Arrows
Steel Sleeve
3" Desired
Machine Steel Sleeve
Steel Stem
Detail showing Plug Expanded in Boiler Tube.
Mach. Steel
Taper Pitch 1½" per Foot.
2" Seamless Drawn Boiler Tube. Must be Clamped here to prevent Buckling.
Tube Plug, See Detail
American Machinist, N.Y.

TOOL FOR UPSETTING TUBING ON INSIDE

The latter acts as a guide and should be equal to the diameter of the finished reinforced end. This plug being secure inside the tube at the correct distance inside the exterior clamp is adjusted to come directly over the plug and the whole apparatus held securely to a firm support.

The anvil shown on the outside acts as a sleeve or guide over the outside of the tube to prevent buckling and should be made in rings, in order to allow it to descend without interfering with the clamp.

The apparatus should be kept in a horizontal position and by a succession of light blows applied to the anvil the tube is gradually upset to an inside diameter equal to the outside diameter of the steel sleeve. In practice it will be found convenient to have a light coil spring between the clamp and the bottom ring of the anvil to keep it in place.

When the operation is completed steel sleeve is withdrawn and the expanding plug slacked off to pass through the reinforced end of tube.

Jersey City. C. BRECHT.

Annealing High-speed Steel

With regard to recent articles on annealing high-speed steel, I have found a very satisfactory way of doing the job.

Take an iron box or tube that can be sealed in the same manner as when case-hardening. Ram fairly tight the articles to be annealed, in saw dust (any kind of saw dust will do) and heat the box so that the tell-tale pieces show the interior of the box to be fairly hot. Allow it to cool down slowly and the steel will be easily workable.

I am using nine different brands of high-speed steel and find no difficulty with them after they have been through the gas furnace in the above-mentioned manner.

Devonport, England. A. T. SUTTON.

A Belt Drive Change

Replying to A. A. Ball, Jr., see page 8, and George H. Handley, page 32, I would say, referring to Mr. Ball's sketch and remarks, that Mr. Ball in summing up his remarks has lost sight of the fact that the object in making the belt-drive change was to get more power, which under the conditions as they existed, meant more belt contact. If Mr. Ball will kindly refer to his sketch and compare it with mine, he will see that I have a great deal more belt contact on the 50-inch pulley than he has, and consequently a great deal more power. Cutting through the joist was no great evil, and the additional power gained more than paid for putting in the extra idler.

Were Mr. Handley to attempt to place the two 12-inch idlers he has shown in his sketch where indicated instead of "having a *veritable* forest of timbers to hold up the necessary bearings and shipper," as he infers I must have, he would have to cut away one of the main supports of the building over which there is some very heavy machinery. There is a little motto very appropriate at this moment and it is, "Think twice before you speak."

Mr. Handley also loses belt contact on the 50-inch pulley with his idea, which means lost power. Both Mr. Handley and Mr. Ball seem to have lost sight of the importance of belt contact in this case.

Judging from the remarks of Mr. Handley, he does not seem to realize that the idlers I have shown in my sketch are on the loose strand of the belt, where the strain and pull are very light and consequently the friction on the idler bearings is very small; so small, in fact, that

after a hard day's run the bearings are cold, which is proof enough of this fact, and being oiled only once a week, the cost of oil is very small. As for the extra cost of oil, and added friction (which is not much), the extra power gained by my greater belt contact more than offsets the extra cost of oil and added friction by producing more work.

Worcester, Mass. ANTHONY.

Artsmithing

On page 231 there appears an account accompanied by illustrations of another of Dixie's discoveries in the art-blacksmith line. I, as a blacksmith with varied experience gained in several quarters of the globe, have been greatly interested in the articles on blacksmith work. The description of Louis Van Boeckel's work appeared several years ago. It was couched in such glowing terms that I was skeptical about the actual merits of Van Boeckel's work and the methods he employed until I saw some samples of his work. These proved conclusively that Louis Van Boeckel is justly entitled to a place in the front ranks of the craft.

James Cran, of Plainfield, up to one year ago had never done any work of an artistic nature, his first attempt being to duplicate one of Van Boeckel's roses, which he succeeded in doing far beyond his own expectations. Another thing to be considered is that Cran is a man approaching middle age, and puts forward no claims of superiority over other smiths further than that he is capable of working from a drawing, or duplicating any kind of blacksmith work from a model, and is equally at home with a marine forging or dressing a tool for the machinist. Cran's artistic work appeared in the AMERICAN MACHINIST just four months after he made his first attempt, and the tools and forge he used were out of all proportion to the work. I have met Cran and seen the most of his artistic work. It has been compared with that of Van Boeckel, and pronounced superior in several ways to that of the great artist. The actual blacksmithing is better, and he has gone nearer to nature, but he falls short in free and easy artistic effect. It is no breach of confidence to say that Cran is at present working upon a piece entirely different from anything he has heretofore attempted, and the outcome is being watched by me with interest.

The work of Ernest Schwartzkopf, already referred to, is of a very much different nature from either that done by Van Boeckel or Cran. That it is beautiful, artistic, and of merit cannot be denied, but it is not purely and simply the product of the hammer and anvil, as is the work of the others, and could not be technically classed as blacksmithing. I have seen a sample of Schwartzkopf's work. It has the hall mark of the thorough mechanic and the artist combined, and also the marks of the chisel and file, making it a combination product of the forge and bench; even riveting has been resorted to in preference to welding. No account of the time taken to produce the various pieces and component parts has been given. A steam hammer must have been used to make the blanks. Judging from the methods of making these flowers from the solid, it may be assumed that Schwartzkopf must have taken twice as long to complete each piece as would be done by Van Boeckel or Cran on similar work.

Each man's work has an individuality all its own. Van Boeckel's lacks the clean blacksmith work characteristic of Cran's and Schwartzkopf's, but excels in natural graceful effect, the finish generally being produced by a process that gives it the appearance of old silver. Cran's work is purely and simply the product of the hammer and anvil, no cutting or filing whatever being done, and is finished by being coated with oil which is burned off, leaving the work with a thin oxide film that gives it the appearance of being newly forged.

Schwartzkopf's work is a combination of all the methods generally employed in the blacksmith shop. The file and chisel play as important a part in bringing his work to completion as Van Boeckel's and Cran's hammers do on their work. The finish on the sample examined seemed to be paint, or some other substance of a like nature applied with a brush. It is refreshing, however, to know that America, which generally gets the credit of being developed only upon its commercial side, has men whose work not only compares well with Van Boeckel's and the old masters, but through Dixie's ability in discovering such men there may be a revival of the arts and crafts on the Western Hemisphere.

New York. H. D. GOWEN.

Casting Iron Around Brass

Your querist A. L. M., page 1026, Part 1, has hit a matter that I have often wanted to experiment upon but opportunity has so far been lacking. He wants to cast his iron around a brass name plate, the latter being made first and the iron run around it as it lies in the mold.

Now, a brass name plate is a bit of ornamental trimming that adds something to the appearance of a machine and, it is frequently nicely polished and then sometimes is lacquered to preserve the finish as long as possible. It thereby becomes a prominent and effectively attractive advertisement for the maker of the machine.

If held in the sand against a mass of molten iron, the least injury the thin name plate could sustain would be discoloration of its brightly finished parts. Easy as might be the task of finishing a small name plate of the usual conveniently handled proportions, the job would be an altogether different proposition when it was welded onto a big chunk of cast iron; assuming, of course, that by any practical process of the founder's art that that undertaking can be accomplished satisfactorily.

For these reasons I have never attempted the proposition that A. L. M. seeks light upon. The alternative methods were so much more promising that the scheme was only desirable as an experiment whereby one might enlarge his knowledge of things practical or merely possible. A. L. M. does not tell exactly what he has tried nor does he indicate what in his judgment are the hitherto unavoidable conditions accompanying his failures. It is not at all unlikely that he has already exhausted the possibilities of several plans and if your readers were aware of these and hence could eliminate them from consideration, or, perhaps, suggest sundry improvements of any of them, we could the quicker, it may be, offer some comments of probable worth.

However, by way of general consideration of the subject, it is doubtless true that the spread between the melting points of brass and iron is the difficulty in question, the higher temperature of the molten iron doing damage to the thin plate of brass against which it rests. Now, if we can take care of the added heat imparted by the iron until the latter freezes or sets, we may be able to preserve the integrity of the brass plate. Obviously it will not do to attempt this object by thickening the plate, the matter of expense is probably an important factor with A. L. M., as indeed it is to most if not all of us.

If we cannot with profit thicken the name plate, then the next best thing, seeing we cannot do it permanently, is to thicken it temporarily by adding a mass of metal to reinforce the capacity for heat storage and conductivity of the brass. Of course, the metal chosen for this purpose should be in kind and quantity suitable to handle the heat burden thus laid upon it. An ingot of copper or a block of aluminum is promising for the purpose. One surface should be planed or otherwise brought into close contact with the plate which is intended to rest upon it while the casting of the iron is in progress. The chill, as it may, perhaps, be best called, is also shaped to avoid interference with the edges of the depressed panel, wherein the name plate is intended to permanently remain in place. The recess in the mold for the name plate and its heat-conducting support will be provided by coring out in the usual way. Now, if the supporting block of metal is big enough and conveys the heat away from the name plate fast enough—why, there you are. Then, also, would come in still another problem, the one that eternally and infernally follows on the inventor's trail, is the new way better than the old?

Cleveland, Ohio. CLEVELANDER.

AMERICAN MACHINIST

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Our circulation for August, 1909, *was (weekly, monthly and European)* 93,450.

September 2..... 34,750

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None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Tariff Reduction on Machine Tools

The Payne tariff bill specifically mentions machine tools and specifies a duty of 30 per centum ad valorem. The previous bill specified a rate of 45 per centum ad valorem on articles composed wholly or in part of iron, steel, etc., and not otherwise especially provided for. Under the provisions of this general section came machine tools. Thus the import rate has been reduced from 45 per centum to 30 per centum ad valorem. For this reduction American machine-tool builders should be heartily congratulated.

In some foreign countries, notably France, the provisions of a differential tariff have acted to close the market to our machinery. This condition will change.

Under the new reduced rate and the automatic maximum and minimum requirements of the administrative sections of the Payne act, we will get the treatment that we give, which will mean a lower import rate on our machinery in some countries and a better chance to enter those markets.

By the provisions of the maximum and minimum clauses the specified rates on all products will be increased 25 per centum ad valorem after March 31, 1910, unless the President, by proclamation, shall extend to the products of a given country the minimum rates, after being satisfied that American goods are not discriminated against in that country. Thus the maximum rate on machine tools is 55 per centum ad valorem. No important country will discriminate against our products in such a way as to cause our maximum rates to apply to its own. The outlook for satisfactory tariff rates in foreign countries having a protective tariff is bright indeed.

The influence of the reduction upon our home markets in regard to imports need not cause a moment's worry. American machine-tool costs compare with similar costs of other nations to the disadvantage of the latter; our specialization has gone much farther than theirs. The reform tariff commission of England heard witness after witness who testified that American machinery products and machines were imported into England at a price from 2 to 15 per cent. below English costs for the same thing.

Thus, through this reduction, the American machine-tool builders stand to win and not to lose. Through its influence foreign trade should be increased and new markets conquered. We repeat, for this tariff reduction American machine-tool builders should be heartily congratulated.

The American machine tool shares with the electrical industry the distinction of acknowledged supremacy and superiority. Following the great work of Whitworth at the middle of the last century in developing standard tools of the nonautomatic class, American mechanics have unquestionally led in machine-tool development, and with the opportunities which will follow the revival of good times the outlook for the future of foreign trade is of the brightest.

The Opportunity Every Boy Has in the Shop

No matter what our walk in life, whether in the shop, the drawing room, or in any other field, the question of education brings up all sorts of ideas and ideals, nearly all of them elaborate and more or less removed from our present line of work. And right here we are very apt to make a great mistake.

We are too apt to think that education means learning something hard and difficult, way beyond our present comprehension, and this deters many from making even a beginning. Just as in school we go step by step through addition, subtraction, multiplication, division and onward, so we should go in whatever line we are, instead of plunging into the middle and trying to swim both ways.

The boy who has been at the drill press a week is very apt to imagine he knows all about it and to long for other worlds to conquer. But there is still much to be learned about drilling, even by the more experienced regarding the best speeds and feeds for different work, and there are many little kinks that help make a man a success on the drill press.

But supposing he is thoroughly familiar with the drill he is running, there are others in the shop, sensitive, multiple or radial, and the logical step is to learn the ins and outs of these at the earliest opportunity. This may have to be done at noon or in some other spare time, but a few minutes spent in this way are apt to be fully as profitable as reading the elevating details of the last prize fight. And it's a lot of satisfaction to be able to tackle any machine the foreman puts you on and show him that you are already familiar with its details.

The same thing applies to lathes, planers, milling machines and other tools in the shop. A little study of their peculiarities at odd moments goes a long way toward giving man or boy a wider knowledge of the tools of his trade and making him more valuable to himself and others.

Even the operator of an automatic screw machine or similar tool has a chance to broaden his knowledge by studying out the various movements, finding just why each movement takes place at the proper time, or what is probably the trouble when it doesn't. These opportunities for education are always at

our command and they can be taken in such easy lessons that there is nothing to prevent starting today.

The sooner the boy who wants to advance begins to take advantage of the things that are next to him and easy to get, the sooner he will be ready for the larger and more difficult things that loom up so large and forbidding ahead.

Then too, there is always the question of doing the work in the best way. Can it be made better or cheaper (maintaining the same quality) with the tools in the shop, or what tools will be needed to make this improvement? If some of the tools give trouble what would you suggest as a remedy if the foreman asked you?

These are good things to think about, they bring up new points of view every day and whether your suggestions are adopted or not, you have added to your own stock of useful information.

New Publications

QUESTIONS AND ANSWERS ABOUT ELECTRICAL APPARATUS. By Clayton and Craig. 176 4x6-inch pages; 96 illustrations in the text; numerous tables. Clayton and Craig, West Lynn, Mass. Price $1.

This is the second edition of the book, revised and enlarged. It is not a text book, neither does it treat of any special branch of electrical engineering in detail, but is a compilation of questions and answers on various kinds of apparatus. It is the outgrowth of a series of such questions and answers prepared to help students in the General Electric's Expert Course at Lynn. The chapter headings are: Direct Current Motors; Induction Motors; Constant Potential Transformers; Constant Current Transformers; Mercury Arc Rectifiers; Incandescent Lamps; Arc Lamps; Meters and Instruments; Steam Turbo-generators.

TABLE OF STRESSES IN ROOF TRUSSES, INCLUDING TABLES OF COMPRESSION AND TENSION MEMBERS, AND EXTRACTS FROM THE BUILDING LAWS OF VARIOUS CITIES. By H. C. Hearne. Pp. 235. 7½x10¼ in.; cloth. New York, 1909: McGraw-Hill Book Company. Price, $4.

This book covers, very thoroughly and systematically, a field that has been somewhat neglected heretofore, and it will be a useful addition to the library of every active engineer, architect and builder. It is often necessary for engineers, architects and builders to know the amount of material, wood or steel, that certain trusses require, yet they cannot afford the time necessary to design them. With this book at hand they can refer to the tables of the stresses in the various members without going into the theory of the subject.

If the trusses are built of wood, knowing the stress, they can tell the size necessary for the members immediately, as they generally know the allowable stress per square inch for the kind of wood used. If the trusses are of steel, they can pick out the sizes of the various members from the information in the tables for tension and compression members in the latter part of the book.

The tables of stresses in the different trusses cover the entire field of trusses thoroughly, from the smallest to the largest loads per square foot, for spans and distances of center to center of trusses that are generally used.

Another large field for the book will be in the designing and detailing offices of manufacturers and fabricators of steel, where time is so valuable that the theory of design is not studied except in special cases. In ordinary work reference is made to tables, which one or more men are likely to have, some of which are questionable and very few complete. If they are complete the owners are careful that they are not published. Many men, who are capable and have had years of experience detailing steel work, cannot design a tension member or a compression member of the simplest kind, but a good set of tables in their hands makes them very efficient men.

Mill buildings, and sometimes office buildings, are purchased by competitive designs, which are made by the steel fabricators, and the designs must be made accurately, in the shortest possible time, and in the most economical way. Tables of values of tension and compression members are absolutely necessary. Tables of angles for various radii of gyration for the different lengths in this book are arranged very nicely for engineers in this branch of the science.

The same tables can be used in the design of plate and angle columns, and angle and lattice columns. If the trusses, columns, ties and struts of mill buildings are designed without the use of such tables it requires very competent men and it is very tedious and likely to cause error. With the present book at hand the design of the trusses can be made in the least time and with little actual knowledge of the subject.

The salient points of the various city building laws, as to steel design, are written with such a mass of information foreign to that subject that it is often impossible to find just the information wanted. Mr. Hearne's book contains the most important points of the building laws for the larger cities in handy form.

Address Wanted

TO ALFRED SYFRIG,
of Thalwil, near Zuerich (Switzerland):

Your dear father, now in his seventy-eighth year, is seriously ill in bed and the uncertainty concerning your fate weighs upon him heavily.

Please do let him know, where and how you are living, so that he may pass his last days in peace and give you his blessing.

Wire or write immediately.

Come home without delay, if it is possible and if you wish to see and speak to your father once more.

Your everloving old mother.

Anyone who is in a position to give information concerning the whereabouts of the above, a middle-sized, brown-haired man of 35 years, silk-weaver foreman, of whom nothing has been heard for the last three years and whose addresses at the time were the following:

Business: Champion Silk Company, Astoria, L. I., U. S. A.

Private: 310 Ninth avenue, Astoria, L. I., U. S. A.

is requested to communicate with his cousin: Alfred Lindenmeyer, 4 Rue Valentin Hauy, Paris, France.

Personals*

Harold A. Buzby, secretary of the Keystone Lubricating Company, is making a two months' tour of the company's Western branches.

Harry Gay, formerly assistant engineer with N. Y. C. & H. R. R. Co. has associated himself with A. L. Dunn & Co., Chicago, Ill., in the capacity of mechanical engineer.

William F. Lee, until recently engineer with the C. W. Hunt Company, has become associated in the firm of Roelker & Lee, conducting a consulting practice in Richmond, Va.

C. E. Allen, who has been connected with both the Lynn and Schenectady works of the General Electric Company, has recently resigned his position with this company.

Charles M. Power is to become general sales manager of the Standard Chain Company, Pittsburg, Penn. Mr. Power has been general manager of the Seneca Chain Company, Kent, Ohio.

C. F. Newcomb, Jr., engineering representative of the Nevada Machinery and Supply Company, San Francisco, has severed his connection with that company, and expects to enter the automobile industry.

Frank H. Hill has been appointed manager of the Atlanta (Ga.) branch of the Sprague Electric Company. Mr. Hill has long been identified with the engineering department of the New York office of his company.

C. Wüst, of Seebach, Zurich, Switzerland, inventor and manufacturer of the double helical gears and the machine for cutting them, described in our issue of last week, is traveling through this country introducing his system. His address is at the Grand Union hotel, this city.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Universal Horizontal Boring Machine with Long Bed

This boring machine, which is constructed with an extra-long bed so as to facilitate the machining of large castings, has been built with a view to accuracy and permanence of alinement, and is especially adaptable to jig work and the like where it is necessary to do accurate boring, milling and drilling, the machine itself being used to lay out the work.

The halftone illustration, Fig. 1, shows the general design of the tool. As may be seen, it is a constant-drive geared machine. The bed is of deep box construction and is heavily ribbed to insure stability, thus giving a solid foundation for the other members of the machine, to keep them in accurate relation to each other and eliminate the necessity of building a foundation under the machine. As a foundation is not necessary, the location of the machine is not confined to the ground floor. The bed rests on three points, facilitating easy leveling, especially on uneven floors, and, at the same time avoiding any undue strain on the bed.

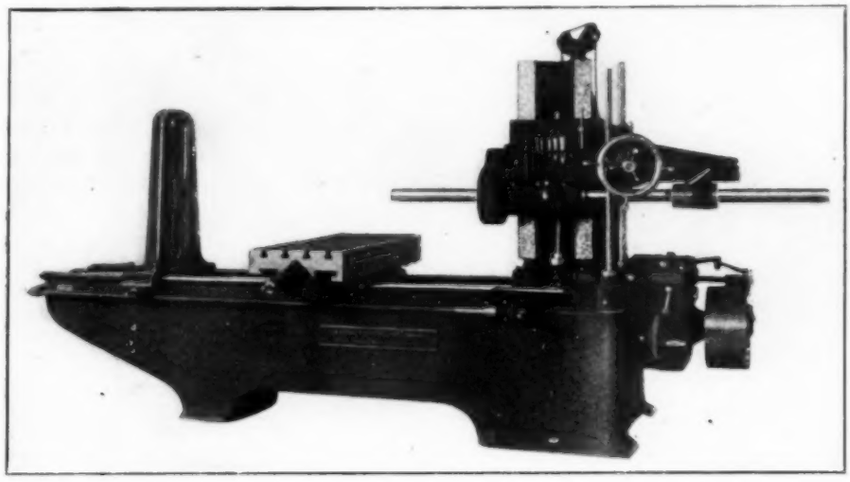


FIG. 1. UNIVERSAL HORIZONTAL BORING MACHINE WITH LONG BED

An important feature of this boring machine is the placing of the head on the right-hand end of the bed. This arrangement permits running of the spindle in the same direction for milling as for boring and drilling and is convenient as well for the operator. The handwheel for the rapid adjustment of the spindle, being placed on the head well in toward the cutter, allows the operator to see the milling cutter and make adjustments at the same time. Work can be bored, drilled and milled in any direction at one setting of the casting when using the rotary table. Jigs and other work can be machined accurately without any measuring, since the machine itself can be used to lay out the work, each feed screw having a large collar graduated to read to one-thousandth of an inch, thus permitting fine adjustments.

The general view shows the location of the feed- and speed-gear box. There is a power vertical feed for the head for milling purposes, and aside from the regular vertical milling feed, the head has a power, quick, constant feed-raising and lowering device, both, however, being operated by a single lever. A hand feed for fine adjustments of the head by a micrometer dial is also provided. The head is counterbalanced, and is moved by a large screw of coarse pitch, suitable arrangement having been made for oiling the sliding surfaces. The feed- and speed-change gears in the gear box are made of steel, and run in a bath of oil. Eight speed changes are secured from the gear box, and these are doubled at the head by the back-gear lever. There are nine feed changes in either direction for the head, one lever reversing or stopping all feeds and retaining their relation to each other.

The spindle has an all-geared drive from a constant-speed shaft. The driving of this spindle is at a point nearest the work and, therefore, torsional strain does not occur throughout the entire length of the spindle. This drive is of special advantage in securing stiffness in large milling cutters and, at the same time, eliminating chatter. The driving gear has a long hub in which the spindle is held by two sliding keys. The spindle itself runs in self-oiling bearings, which have an individual oil compartment containing enough oil for about 20 months' running. The bronze bearings, which are fitted into the bearing proper, have a groove cut the entire length in which is laid wicking with its ends dipping into the oil compartment below. The bearing proper is split also and provided with clamp screws for taking up any wear that may occur.

The tight and loose pulleys on the driving shaft will be noticed at the end of the machine. The loose pulley is slightly smaller in diameter than the tight pulley, so that there is practically no tension on the belt when running on the loose pulley, thus minimizing the wear of this pulley on the shaft. The loose pulley is of single-piece construction, an oil reservoir being cored out around the bearing, and this space filled with cotton waste and oil.

FIG. 2. AUXILIARY TABLE FOR HORIZONTAL BORING MACHINE

Wicking is laid in a groove cut in the bearing, the ends of which dip into the reservoir below.

As will be seen, the platen is of ample thickness to avoid springing when clamping down the work, and has power feed in either direction with automatic stop. The screw which moves the platen carries a dial reading in thousandths, and the gears which operate the feed screw are incased and run in oil. There are four milled T-slots running the entire length of the table, and provision has been made for applying the rotary table. The feed motion is taken from the driving shaft which runs at a higher speed than the spindle. This makes it possible to obtain nine feeds without gearing up, thus avoiding undue strain on the feed gears and bearings. The fine feeds are obtained by reducing gearing. The rotary table is 24 inches in diameter, and is graduated in ½ degrees. The milling feed for the table, making the machine universal, together with the rotary table, permits finishing at

one setting many kinds of work which would otherwise require resetting and finishing in other machines. This graduated revolving table allows holes to be bored and drilled, and surfaces to be milled at various angles at one setting. An auxiliary table, as shown in Fig. 2, is provided for work overhanging the regular table; it has a T-slot milled its entire length. This auxiliary table for the machine is an essential factor in the machining of large castings since they can either be bolted to the table or travel on it.

The outer support bearing for the boring bars is gibbed to the internal guiding surfaces of the support. The raising and lowering of the bearing is accomplished by means of the screw connected by spiral gearing and splined shafts to the elevating screw of the spindle head, so that the two move together. Provision has been made for realining the bearings in case of wear. The outer post is accurately fitted to the bed of the machine and is moved longitudinally on the bed by a hand crank. It can be easily removed from the machine by removing the bracket at the end of the bed and pulling the post off, and can also be replaced in exact alinement without any trouble.

The extension boring bars are provided with bushings to fit in the outer bearing, and these bars are fitted to a No. 4 Morse taper hole in the spindle. The spindle also has a slot for locking the extension boring bars by means of two wedges in addition to the usual drift slot.

Two face-milling cutters (10 and 2 inches diameter, respectively) may be furnished with the machine. The hub of the driving gear forms a faceplate to which the 10-inch face-milling cutter is rigidly fastened by means of four cap screws. The 2-inch face-milling cutter is fastened to an arbor which is fitted to the No. 4 Morse taper hole in the end of the spindle. The 10-inch cutter is provided with a center hole large enough to allow the spindle carrying the 2-inch cutter to pass through. Thus either cutter may be used without the necessity of removing the other.

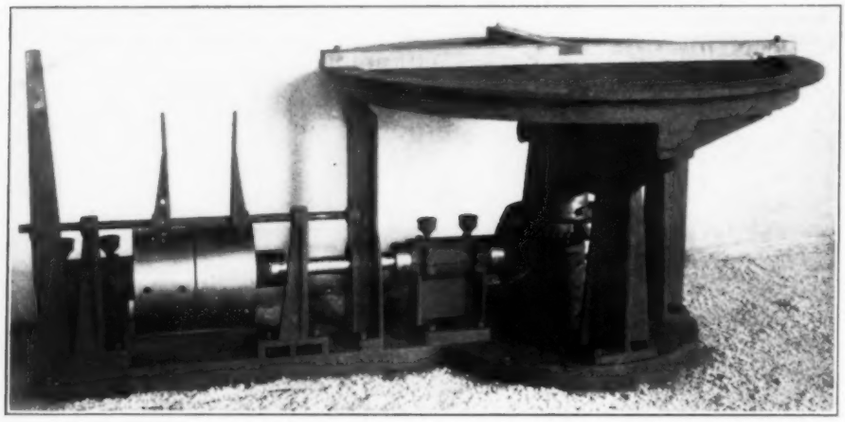
This machine, known as the No. 2½, will take 94 inches between the faceplate and the outer support for the boring bar. The greatest distance from the top of the platen to the center of the spindle is 22¾ inches; and the platen, which is 20 inches wide by 42 inches long, has a cross-feed of 34 inches. The machine is built by the Universal Boring Machine Company, Hudson, Mass., the selling agents being Hill, Clarke & Co., Inc., of Boston and Chicago.

Horizontal Disk Grinder

This is a new type of grinder recently brought out by Chas. H. Besly & Co., Chicago, Ill., for grinding large surfaces, such as fire doors, large gear-case covers for automobiles, and similar work. The disk is 48 inches in diameter, and is surrounded by a guard ring raised about ¾ inch above the grinding disk. This prevents the work being thrown off the disk and also affords a resting place while handling the work to be ground.

The disk has the usual spiral grooves of the Besly grinders, and is driven by a spindle 3 inches in diameter in the bearing, with a 2-inch stud for centering the grinding disk. The bearings are 9 inches long, and the stepped bearings consist of two hardened tool-steel blocks, one being secured to the spindle and rotating with it.

The power of the machine can be seen from the 8-inch driving belt on a 12-inch pulley, driving the disk through bevel gears with planed teeth at the rate of 400 turns per minute, being one-half that of the driving shaft.

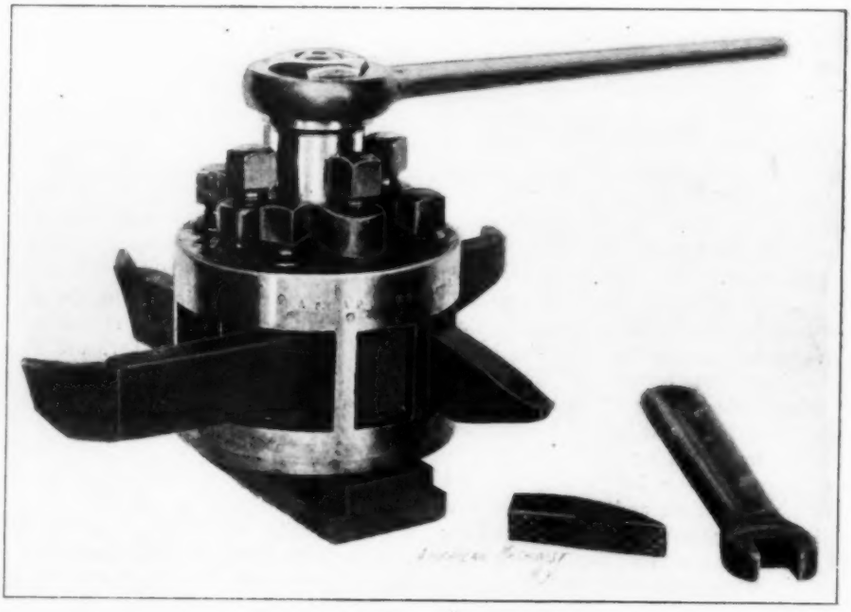


BESLY 48-INCH HORIZONTAL DISK GRINDER

A Turret Tool Post

The illustration shows a turret tool post which has recently been brought out by the Multiple Tool Holder Company, 3197 West Forty-eighth street, Cleveland, Ohio. The device fits in the T-slot usually occupied by the tool post, and converts the ordinary engine lathe into a turret lathe. The T-head fitting the tool-post slot is provided with indexing pins, one in each end, and the turret head is provided with index holes, eight in number, so that the head can be swung either 45 or 90 degrees. The indexing mechanism is tool steel hardened, and the body is a steel casting.

The individual tools are adjusted to hight by shoes, one of which is shown in the cut; they are held by two set screws each and the turret can be used for work either on centers or held in the chuck. A



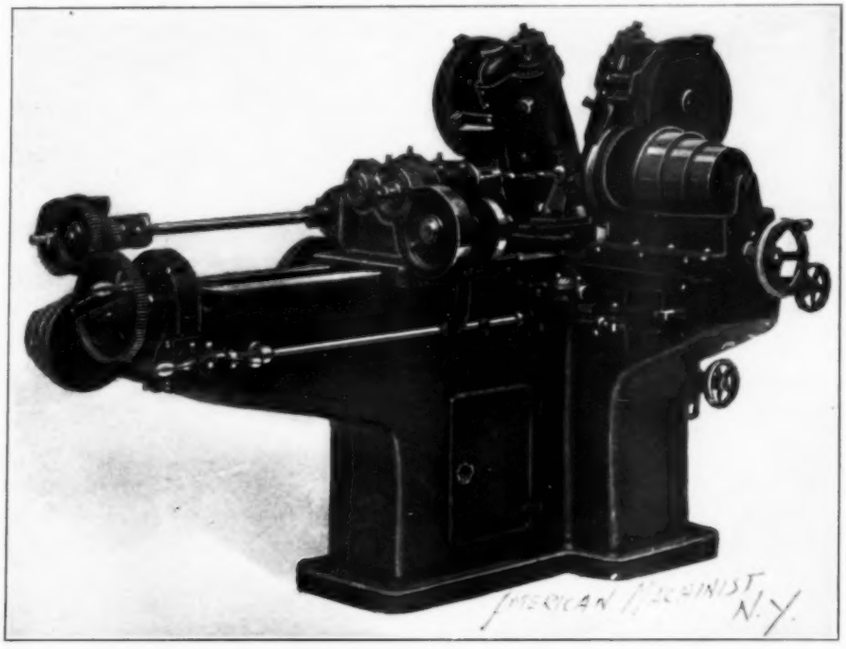
A TURRET TOOL POST

half turn of the center nut releases the indexing pins so that the turret can be turned.

German Twist Drill Milling Machine

This is an automatic milling machine designed for the manufacture of twist drills from 5/8 to 4 inches in diameter and up to 39 inches long. There are two milling heads, each driven by an independent cone, and each can be swiveled at any desired angle, according to the twist of the drill being made. The drill is firmly supported close to the milling cutter to insure a smooth clean cut. It can be adjusted for either right- or left-hand and the web can be either straight or tapered, or a combination of the two if desired. All adjustments are provided with a scale, which, on the machines for use in metric countries, read to 1/10 of a millimeter, or about 0.004 inch. After the machine is started, its entire operation is automatic, the feed being stopped in any desired position by automatic trips.

The machine is heavily geared, has eight changes of feed, and will mill a 1 3/8-inch drill of standard length complete in 14 minutes. Other records are 80 half-inch drills, to 24 two-inch drills per day of 10 hours. Although not regularly supplied, it can be arranged for cutting spirals of varying pitch if desired. It occupies a floor space of 6 feet 3 inches by 8 feet 3 inches, and weighs about 4700 pounds. It is built by Biernatzki, Chemnitz, Germany, and represented in this country by Ducas & Co., 50 Church street, New York City.



GERMAN AUTOMATIC TWIST DRILLING MACHINE

Le Blond Heavy Duty Lathes

The illustrations show the 20-inch size of a new line of heavy-duty lathes built by the R. K. LeBlond Machine Tool Company, Cincinnati, O., in four sizes, from 16- to 30-inch, and while there is nothing radically new, there are a number of very interesting features which can be seen from the several illustrations. The lathe shown will remove 32 cubic inches of 50-point carbon steel per minute, taking a cut 1/4 inch deep with 1/6-inch feed at a cutting speed of 65 feet per minute.

The headstock is very heavy, is driven by a large 3-stepped cone together with double friction back gears and a two-speed countershaft, giving 18 changes of spindle speed over a carefully selected range. The spindle is hollow, with hardened and ground journals, the pedestals have large oil chambers which are filled from the front of the lathe and the oil from these is fed to the cast-iron bearings by felt pads which remove the danger of dirt or grit entering the bearing and require oiling but once a week.

The end view, Fig. 2, shows several new features, the new form of bed and the fact that the spindle is back of the center, the tailstock of heavy design and the substantial taper attachment The tailstock is guided by 1 V at the back, and has a flat bearing in front, while the carriage has a flat bearing at the back and a new form of V in front. The front bearing is 15 degrees on top and has a 70-degree back angle, which is done to resist the heavy outward thrust and also present a large bearing surface to resist

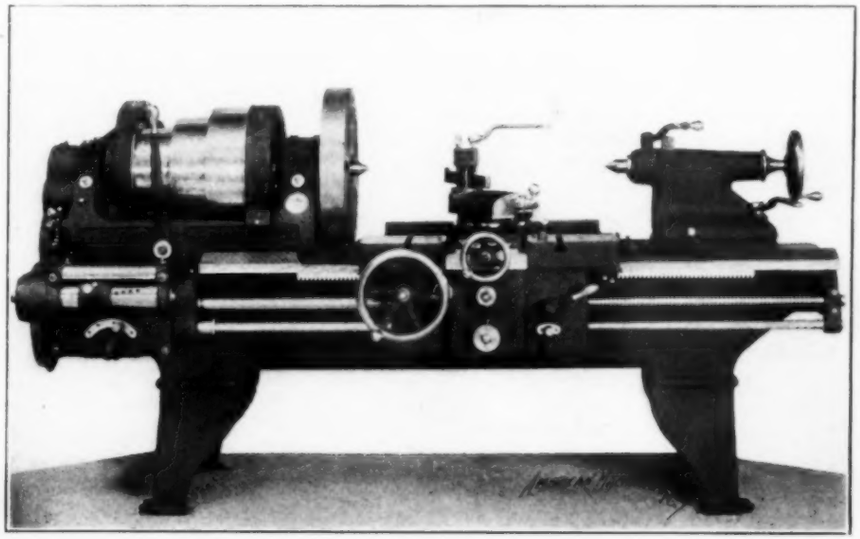


FIG. 1. NEW 20-INCH LE BLOND LATHE

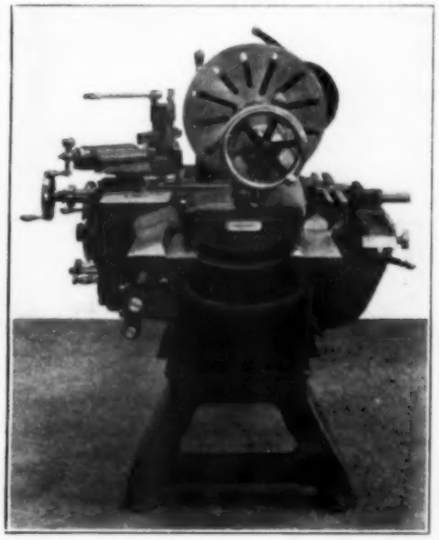


FIG. 2. END VIEW, SHOWING SHEARS

vertical wear. The bed is unusually deep, and is braced by cross ties and the front wall of the bed is in the form of a deep I-beam section directly under the front bearing. In addition to this, the metal around the holding down bolts has been greatly increased to insure rigidity at this point. The carriage is of the double-wall type and cast in one piece. Its alinement is preserved by tapered gibs at each end of the front of the bed, and is held down by a flat gib at the back. These gibs are accurately located in position, and are designed to automatically compensate for wear. Wipers are provided to keep grit from the ways and also assist in oiling them. Guards are also provided at each end of the carriage, as can be seen.

Fig. 3 shows a cross section of the bed through the carriage and taper turning attachment, and gives a good idea of the relative proportion of parts. The offset center line of spindles is clearly shown here, being 2 inches on the 20-inch lathe. The substantial support of the taper turning attachment is also shown, while the method of adjusting this can be easily seen in Fig. 2. This also shows the construction of the tailstock, the graduations for setting it off, and also the very rigid tool post which is used on these lathes.

The apron is of the bevel-gear type, and the general construction is shown in Fig. 4. This form of apron supports every stud and shaft at each end, and by carefully fitting this to the carriage with a tongue, and using four large bolts, it has been found possible to do away with the auxiliary ways at the lower end of the apron, which overcomes the difficulty of the uneven wear between the upper and lower slides.

Longitudinal and cross feeds are operated by a single friction of large diameter which is designed to have very little work put on it. The feeds are engaged by an in-and-out movement of the knob in front, and in a central position it disconnects all gearing when the lathe is used for screw cutting. There is also a safety device which prevents the engaging of the feed and the lead screw at the same time.

The change-gear box is the same as has been used on Le Blond lathes for some time, and claims the distinction of being the only device in which the entire mechanism is contained in one unit. This gives nine changes of feed by a cone of gears, and these are quadrupled by a sliding gear transmission, which is operated by the lower lever of the feed box. This permits the use of a direct-reading index plate, which makes mistakes almost impossible. All threads from 2 to 30 can be cut, and all gears in the feeding mechanism are made from drop-forged steel. The same box drives the feed rod and an intermediate gear is mounted on a quadrant so that special or compound gearing can be used to cut special threads, either English or metric with the standard lead screw, or *vice versa*.

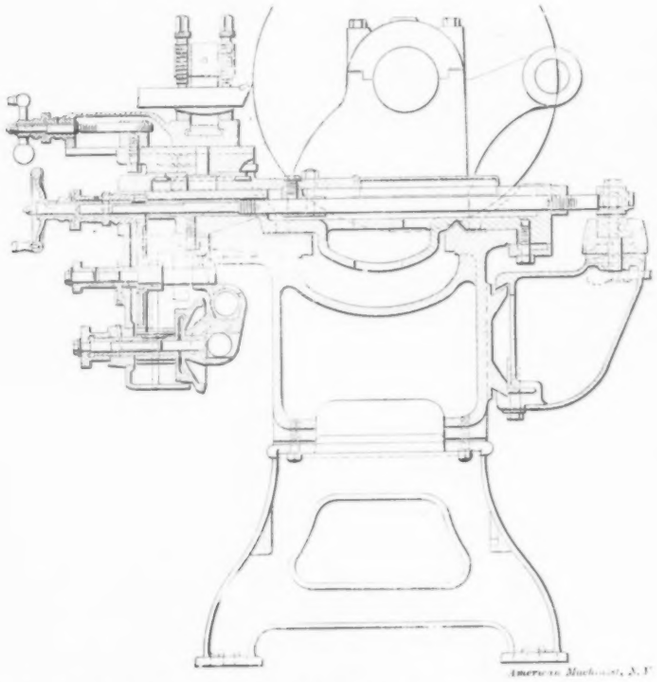


FIG. 3. A CROSS-SECTION THROUGH CARRIAGE BED AND TAPER ATTACHMENT

Combination Grinder and a Tool Post

Fig. 1 shows a tool holder which goes around the tool post instead of through it, as is usually the case. Its large bearing surface enables it to be clamped very rigidly, and its shape allows the tool to be elevated or depressed, while it remains horizontal at all times. It can be used for either turning or boring, and right or left hand, the small yoke and thumb

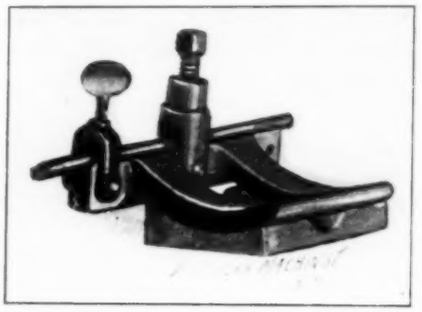
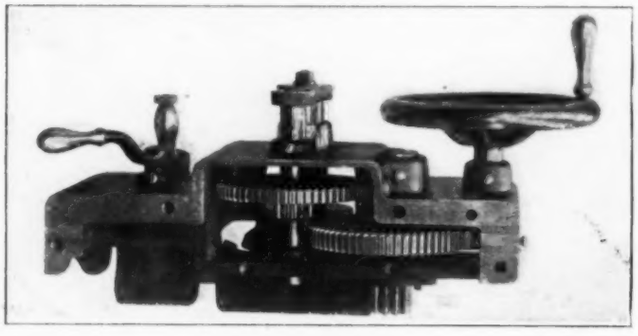


FIG. 1. A NOVEL TOOL HOLDER



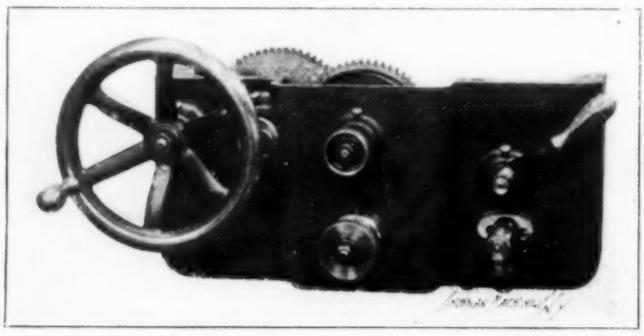


FIG. 4. THE APRON CONSTRUCTION FROM TOP AND FRONT

screw being readily transferred from one end to the other. It is made in five sizes, from the watchmaker's lathe up to a 30-inch, by the Robinson Tool Works, Waterbury, Conn.

The machine shown in Fig. 2 is a combination tool-room grinder, which will handle twist drills, milling cutters, surface grinding of dies and similar work, and

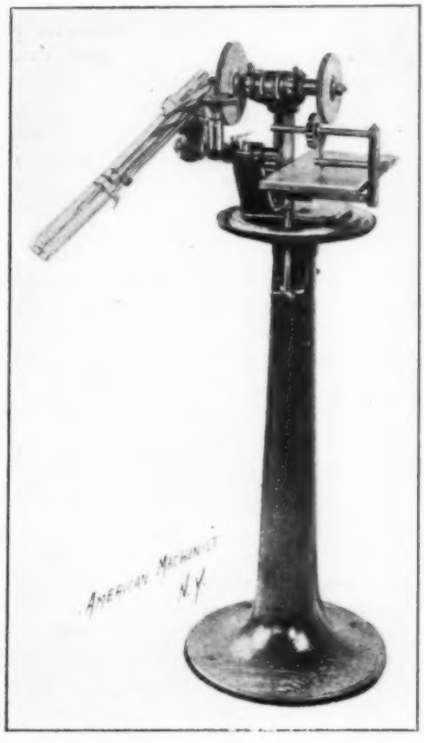


FIG. 2. A COMBINATION GRINDER

also tool sharpening by the use of the small hand rest on the left-hand wheel. For surface grinding it is necessary to remove the fixture for holding milling cutters as shown, and with this out of the way, the table can be adjusted by the elevating screw beneath. It is also made as a bench machine.

The British Tariff Commission and the Machinery Trade in England

BY ARCHIBALD J. WOLFE

The report of the British Tariff Reform Commission on the engineering industries of England, particularly with regard to imports and exports and the competition with foreign countries, presents a mass of evidence and statistics gathered by the commissioners, a study of which furnishes food for thought not only for the British machinery trade but also for American machinery interests. As far as machinery is concerned, the United Kingdom is, as is thoroughly well known, a free-trade country. The witnesses from every branch of the engineering industry, being the representative manufacturers of Great Britain, by a strong majority advocated a tariff of 10 to 20 per cent. on foreign machinery.

In its introduction the report recites the fact that the engineering industry in Great Britain had progressed, but not so rapidly as that of their competitors in Germany and the United States. The rapid expansion of foreign industries, the greater security they enjoy in the home market where they are protected by tariffs, the greater power of competition abroad are duly noted. Of the witnesses examined 77 stated that they did not suffer from foreign competition in the home market, principally because they worked for the Admiralty and the War Departments, where foreign competition is excluded. More than 400 firms, however, complain of foreign competition and over 500 distinct products are mentioned as being competitive foreign importations. Many instances of dumping are mentioned. Complete domination in machinery of certain classes by foreign makers is also found, thus for instance 95 per cent. of all flour ground in the United Kingdom was discovered to be ground by American-made machinery.

EXPORTS AND IMPORTS OF MACHINERY INTO THE UNITED KINGDOM

The exports of British engineering products have greatly increased and amounted to almost $160,000,000 in round figures for 1907. India takes one sixth of the total; Russia, Germany, France, Argentina, Japan, Australia, Italy and Belgium are other important markets. The increase in the export of locomotives to South America and India is noted, and of sewing machines to Russia. Great increases mark the export of mining machinery to the British colonies, such as South Africa and Western Australia and of textile machinery to India.

Foreign tariffs have greatly interfered with the exports of hydraulic machinery, engines and locomotives. The differential duties in favor of the United States have greatly injured the British machinery and engineering exports to Porto Rico, Hawaii, Philippine Islands and Cuba.

The machinery imports of the six largest industrial competitors of the United Kingdom have increased by almost $61,000,000 in 15 years, and of these increased imports only $8,500,000 came from the United Kingdom. The remaining importation has been supplied by mutual exchanges between these six countries encouraged, except in the case of the United States, by a network of Central European treaties. The machinery exports of these countries have increased in the same period from about $54,000,000 to $220,000,000, of which their exports to the United Kingdom rose from $4,500,000 to $22,500,000.

The comparative positions of the machinery industry of the United Kingdom and the six principal countries were reversed inside of 15 years. In 1891 the machinery exports of the United Kindom were $25,000,000 more than the six largest competing foreign countries. In 1906 they were $85,000,000 less. In this period the increased exports were: United Kingdom $55,000,000, Germany $75,000,000, United States $62,500,000.

The report notes the unusually complicated nature of the engineering industry, which is really a vast group of industries, expanding as more and more lines of production are becoming revolutionized by the application of machinery. The figures in the report are of considerable interest. The first table shows the imports of machinery and millwork into England from six principal competing countries, for 1897, 1902 and 1907, and the corresponding increases, in thousands of pounds sterling:

To	1893-97.	1898-02.	1903-07.	INCREASE, (FIRST TO LAST PERIOD).	
				Amt.	Per Cent.
Russia.....	1,903	2,592	1,924	21	1
Germany..	1,651	1,846	2,016	365	22
Belgium...	720	816	808	88	12
Italy.....	470	622	1,225	755	161
Argentina.	416	446	1,727	1,311	315
Japan.....	716	572	1,020	304	42
India.....	2,063	2,435	3,896	1,833	89
Austr'lasia	719	1,435	1,452	733	102
France....	1,205	1,473	1,614	409	34

TABLE 1. IMPORTS INTO ENGLAND OF MACHINERY AND MILL WORK IN THOUSANDS OF POUNDS, STERLING.

Table 2 shows the exports of machinery and millwork from the United Kingdom to principal consuming countries in thousands of pounds sterling:

From	1897.	1902.	1907.	INCREASE, 1897-1907.	
				Amt.	Per Cent.
United States...	1620	2984	3117	1497	92
Germany.....	303	763	906	603	99
Belgium	88	313	378	290	330
Holland.....	95	252	333	248	260
France.....	112	223	190	71	60
Canada.....	30	62	105	75	250
Total from all countries....	2371	4761	5312	2941	125

TABLE 2. EXPORTS FROM UNITED KINGDOM OF MACHINERY AND MILL WORK IN THOUSANDS OF POUNDS, STERLING.

LOSS OF ENGLAND'S MACHINERY EXPORT TRADE

The evidence of loss of export trade is of very great interest. The British trade has been reduced as follows, by countries and articles, due to tariffs and other adverse conditions: Austria-Hungary: Trade in economizers stopped; in engines reduced from 200-400 per year to 25-30 engines per year; fixed engines-trade entirely gone; machine tools cut off by the

tariff; threshing machines reduced from 800 to 80 sets; portable steam engines trade abandoned.

Germany: agricultural machinery, mining tools, structural machinery, portable engines, cranes trade practically ceased.

France: Machine tools tariff makes trade impossible; locomotives can export only under exceptional circumstances.

Italy: Tariff practically excludes British machinery.

Russia: one firm lost $12,500 a year in machine-tool trade, or nearly 8 per cent. of entire output due to rise in tariff. Large plow trade practically disappeared.

United States: Rock drilling machinery trade lost since McKinley tariff; electrical trade practically ceased; mining tools trade lost since tariff was raised.

Hawaii, Philippines and Porto Rico: new duty cut off trade in sugar machinery.

Foreign Competition in Machine Tools

In suggesting an import duty on engineering products imported into the United Kingdom, the British manufacturers imagine that the advantage of protection would arise not merely from the duties, but from the fact that such a policy would necessitate the conclusion of commercial treaties and an adequate Government organization, like a Ministry of Commerce. An import tariff, a witness hoped, would secure the home market and prevent violent fluctuations in the output, render more certain the continuous employment of capital, machinery, labor and organization on an efficient basis. With regard to machine tools, the manufacturers of these bitterly complain of foreign competition. Smith's tools, engineer's tools, lathes, drilling machines enter directly into competition with those of British make. The machine tools imported are generally of American and German origin. In the opinion of the manufacturers the idea that they are superior to British makes is a mistaken one.

The British Tariff Commission finds that the United States manufacturers have made great progress in the manufacture of machine tools. They have developed special machines for certain classes of work and now have a considerable hold on the British market. "My own experience," says a witness, "of the American machine tools has been extremely good. I cannot get such good tools in England in design and quality of steel in any way, but chiefly in design and the convenience of the machine. There is no reason why the English should not make them every bit as good, only I think the Americans are a little quicker."

Trade in Woodworking Machinery

The trade in woodworking machinery is said to have suffered greatly from dumping. American manufacturers turn out enormous quantities of woodworking machinery, all the parts being identical, so that by turning these out in thousands they are able to undersell their competitors. Witnesses say that the United States machines do not last as long as the British-made but they praise them for convenience and handiness.

The views of certain witnesses are of great interest because of the prominent position they occupy in the engineering industry, which qualifies them especially to form a competent judgment.

Mr. Allan Ransome, of A. Ransome, Ltd., Stanley works, Newark-on-Trent builders of woodworking machinery, stated that he had been connected with the industry for 50 years. His company has patterns for 1000 different machines. Half of the machines built by them are for export. They sell a great deal to the Argentine Republic. Much of their business with the colonies is due to British engineers located there, and to Crown agents of the colonies in London. Their private trade with the colonies has been ruined by American and German competition. They do a good business with Colonial railways and with Colonial Governments, but when it comes to selling to a small dealer in Adelaide or some other Colonial town they have no chance. We could make the same articles as the Americans, if they are not patented. Very few of them are. We are seriously considering if we shall not work along these lines. We could make the machines if we liked and I dare say at the price, if we went on the dumping plan. The managing director of J. A. Fay & Egan Co., our largest competitors in America, came over to our works and said to me when he left me: "If you are satisfied to make the same class of machines that we are, to manufacture them wholesale and on the same lines that we do, you could beat my firm out of every market in the world, except the United States."

The witness finds a better quality of metal, tougher castings and better finish in American machines. But he finds them light. While the English build a machine to last for 50 years, the Americans are satisfied to make a lighter machine and to replace it when they can introduce one with improvements. This witness says: "A 10 per cent. duty would be of no use to us; we should put the same duty on goods coming from the United States and Germany that they put on ours. They might bring theirs down and we would bring ours down.

Some Foreign Costs are Considerably Less

J. Tangye, a machine-tool manufacturer, stated to the Commission: "Lathes and milling machines from Germany and the United States are not sold in this country below price, but so little above prices that it is very hard to compete. In America prices are admittedly 2½-5 per cent higher for the same machine as disclosed by the United States Commission, and in practice a great deal more."

Another firm of machine-tool manufacturers testified: "Germany sends us stocks, dies and taps for threading at 25 per cent. less than our cost price; Germany and the United States send us twist drills and milling cutters at 15 per cent. less."

The Tariff Commission submits its report without recommendations, though with considerable comment, but the general tenor of evidence appears to be in favor of a larger measure of protection to the British engineering industries than they enjoy at the present time.

Trade Opportunities in Japan

By M. de Moreira

Since Japan promulgated the shipbuilding law of March, 1896, a good deal has been accomplished by that nation. In the last few years especially, Japan has grown as a naval power not to be despised, and as a result home shipbuilding has developed very rapidly.

Shipbuilding

The most important of all the shipbuilding concerns in Japan is the Kawasaki Dock Company, which is situated at the western extremity of Kobe harbor. The capital stock of this company is $5,000,000, with a bonded debt of $2,500,000. The company employs over 1000 men and has constantly many ships under construction. According to reliable information they have at present under contract the construction of two of 8600 tons, three of 6000 and one of 2000 tons, all for the Imperial navy, and three torpedo boats and one destroyer for the Siamese government. The company has nine shipbuilding berths; a graving dock of 425 feet in length, and two patent slips of different lengths. As described in my last article, the steel foundry which this company has purchased is connected with the yards.

The next plant in size is the Osaka Iron Works and Shipbuilding Company, which also does a large business. The first shipbuilding yards of these works were established in 1880 at Ajikawa, on a tongue of land in the river, with a water frontage on both sides. On this land are built the general offices, a graving dock of solid masonry, the foundry, machine, boiler and smith shops. There is also a pipe foundry which has a capacity of 15 tons a day.

The new shipbuilding yard was opened at Sakurajima in 1899 and has a water frontage of more than 1000 feet. Situated a quarter of a mile from the mouth of the river and a half mile from the pier in the harbor, it is equipped for building all sizes of steam vessels. Its location has been very well chosen as the river at that point is 1000 feet wide, and ships

having a draft of 18 feet can be easily launched. There is another yard for building wooden vessels, which is located across the river and is fully equipped for that purpose. The company employs 4000 workmen and fills many orders of passenger steamers and smaller vessels.

The foundry connected with the works produces steel by the Siemens system. The machinery is run by electricity, and in the building are two 20-ton and two 5-ton electric cranes. Recently a large hydraulic press of about 2000 tons pressure was installed. The company manufactures cast-steel rudders, propellers, and all kinds of marine and land engines. These brief descriptions will surely make the American manufacturer realize the great opportunities there must be in Japan for machinery and machine tools. A nation which, in such a short time, has progressed so rapidly in the construction of men-of-war and steamers of every kind, must necessarily be the purchaser of modern machinery and it behooves Americans, who are in easier communication with Japan than the European countries, to push the sale of their factory products.

Dock machinery is also needed; the Tokyo Warehouse Company has just constructed a new steel pier in connection with warehouses at Wada Point, Kobe. The pier is fully equipped with six railway tracks, stationary and portable cranes, etc. Another pier is to be built in Osaka. Japan is reaching out nearly everywhere with its steam lines. The Tokyo Kisen Kaisha Steamship Company is to start a line which will go to Argentina and Chile and another which will open a new route, connecting the Atlantic and Pacific oceans, by a branch line, via Tehuantepec.

The Lumber Industry

Undoubtedly the United States manufactures the best sawmills and the most uptodate lumber machinery, and for that reason American manufacturers of such products ought to find in Japan a very good field. I copy the following from a Japanese publication: "The Department of Agriculture and Commerce, which established a sawmill at Akita, making a grant of $100,000 to develop the business, has obtained a vote of $150,000 toward the fund for the extension of the lumber business, and new government mills are to be established in Hagano and Gomori. Before the end of this year there will be nine timber mills in Akita, Aomori and Miyaga, all worked by the government." The director of the forest bureau admits that Japan is the only country in the world which takes upon itself the working of the timber and lumber business. In many forests reserved by the government there is an almost inexhaustible supply of timber, but these forests are remote from railways, rivers and seaports and much expenditure is necessary for opening roads or constructing other means of transport in order to make such timber available. District forest offices will, however, not work mills regardless of profit, as strong competition exists among them. It is stated that the government will only supply timber products to merchants in Japan, the export of timber by the government mills having been confined to supplying sleepers to the South Manchurian Railway Company. American lumber men in the States of Washington and Oregon are certainly the losers by Japan's progress in that direction, as all the lumber and timber landed at Hankow used to come from these States, whereas now they are supplied from the native mills.

Knitting Mills

The knitting industry is also going ahead in Japan. In Osaka alone there are over 1000 manufacturers of knit goods, and, what is most remarkable, they furnish 60 per cent. of the imports of knitted goods in India. The deduction from these figures is that Japan must have uptodate machinery. As a matter of fact, the Japanese have invented a special machine which costs only one-sixth of a German machine and turns out twice the quantity of work.

There is one thing the American manufacturer must remember and that is, that though the Japanese knitting machinery is cheaper than the German, it nevertheless, turns out work of inferior quality and that though the American machines are expensive they are cheap when the quality of the work is taken into consideration. According to good information, the United States exported last year to Japan only $2701 worth of knitting machinery.

Until now the Japanese government seems to have ignored the smaller branches of manufacturing industry. Changing its policy, the government has decided to encourage them and to import the less expensive descriptions of machinery, such as finishing machines for cotton and silk fabrics, paper ware and metal ware, porcelain machines, etc., which can be used by small factories, and these will be hired out to producers. In one way the measure adopted by the government is only self-protecting, as many so-called Japanese goods are made in Germany. Thus, by reducing the cost of production to its own people and furnishing them labor-saving machinery, the government will enable them to compete with the foreign imitations and also check their importation.

Certainly opportunities are awaiting American manufacturers in Japan, especially as wide-awake people like the Japanese can appreciate quickly the advantage of superior machinery.

It is to be profoundly regretted, however, for the future of American industries that many inventions have been imitated and trade marks and other industrial rights abused in Japan. The Japanese chamber of commerce is doing its utmost to have this practice stopped and is refusing to register trade marks that might be intended to deceive the public.

Fusion Welding with Liquefied Lighting Gas

By Alfred Gradenwitz

The local heating of metals to melting temperature is known to require a point flame of very high temperature, which has so far been mostly produced by oxy-hydrogen torches, i.e., torches to which hydrogen is supplied as fuel, and pure oxygen in the place of combustion air. The flame produced with this torch possesses a temperature susceptible of melting most metals. In fact, the remarkable intensity of oxy-hydrogen flames, as compared with those of a mixture of air and hydrogen, is accounted for by the fact that the oxygen of air contains nitrogen to the extent of 79 per cent. which takes no active part in the chemical process of combustion, while absorbing a large amount of the combustion heat, and thus cooling the flame.

Oxy-hydrogen torches have been used of late years with excellent results in the most varied branches of industry, for fusion welding, the metal being melted locally and allowed to flow together at the seams, without the use of any auxiliary substance or process.

Experience has shown that all gases containing, as elementary components, hydrogen and carbon are adaptable for fusion welding, and the question as to which gaseous fuel is most convenient, mainly depends on the cost of equal amounts of heat units available in the gas as well as on the convenience of the apparatus used. The original oxy-hydrogen process has been found the most convenient and reliable welding method, both gases being sold, in the compressed state, in bottles to which reduction valves for controlling the pressure are readily fitted.

Owing, however, to the considerable specific volume of hydrogen, and the corresponding expensiveness of its transport, this gas has been partly replaced by acetylene.

An important advance has been recently made in the gas industry by Mr. Blau's invention of a process for generating liquid lighting gas. This material, under atmospheric pressure, is gaseous like air, but becomes liquid as soon as its pressure undergoes a moderate increase. In this condition it is extremely suitable for transportation to any distance, like other liquid fuels, such as oil, alcohol, etc.

Blau gas is as transparent and clear as water and possesses, of all commercial gases, the highest lighting and heating values. Similarly to oil gas, it is a combustible material obtained from mineral oils by distillation in red-hot retorts, and

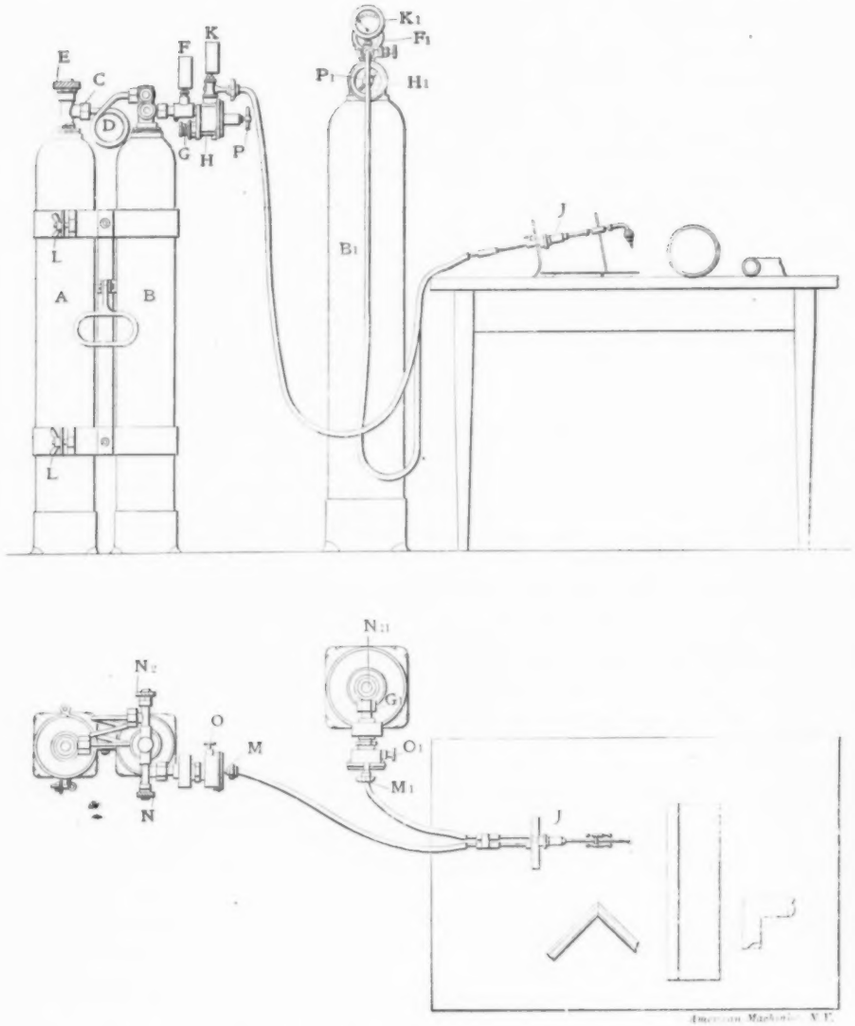


FIG. 1. DETAILS OF BLAU LIQUID-GAS WELDING APPARATUS

gage *F* for determining the gas pressure in the bottle *B*, and the gage *K*, on which is read the gas pressure, controlled by the spindle *P* of the safety valve *G*.

(3) The reduction valve *H1*, the jet controller *F1*, the pressure gage *K1* and the safety valve *G1* for oxygen.

(4) A Blau gas conduit, with nut *M* for the gas.

(5) A Blau gas conduit with nut *M1* for oxygen.

(6) The welding torch *J* with exchangeable mouth-pieces.

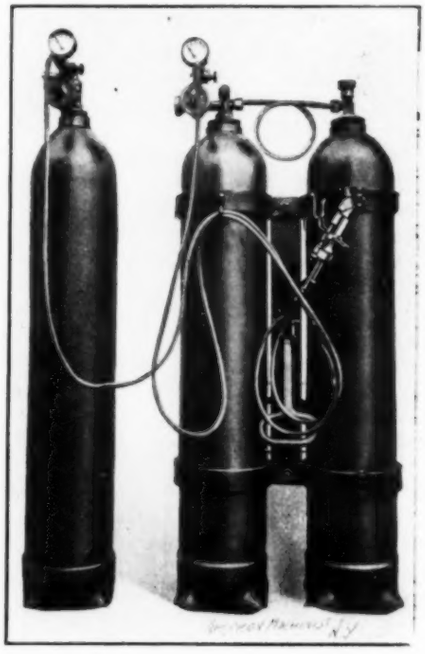


FIG. 2. LIQUID-GAS WELDING OUTFIT

comprises the same chemical elements and compounds (hydrogen, methane, saturated and nonsaturated hydrocarbons) as coal gas, though in considerably different percentages. However, this gas is absolutely free from carbon monoxide and accordingly possesses the advantage of not being poisonous. During its solidification, it contracts to about 1/400 of its initial volume and therefore can be introduced into readily transported steel bottles of different sizes.

This liquid gas has been found to be a fuel which, while being as convenient as compressed hydrogen, is even cheaper in operation than acetylene, for the fusion welding of metals. A further advantage of Blau gas-oxygen welding is the fact that the apparatus (which even in the case of large outputs is readily transported) is free from any water, and accordingly is exposed to no destructive chemical influences such as rusting. On the other hand, the apparatus is as cheap as any, and as the gas is sold in a purified condition, it does not require any cleansing or discharging of refuse, such as lime, slime, etc.

In Fig. 1 is shown a Blau gas-oxygen welding apparatus. This consists of the following parts:

(1) A transportable gas bottle *A* connected to the steel bottle *B* serving as gas reservoir, by the copper tube *D* and intermediary locking valve *N2*.

(2) The reduction valve *H* connected to the locking valve *N* with the pressure

This apparatus is also shown in the halftone, Fig. 2.

Blau gas is also used to advantage for high-speed soldering. The relatively high temperature required for a number of technical processes is hardly obtained by means of ordinary bunsen burners. In order, therefore, to increase the intensity

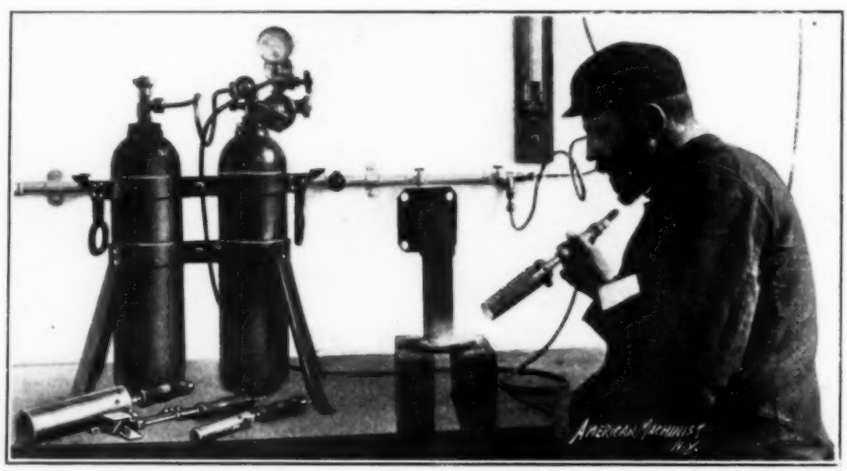


FIG. 3. BLAU LIQUID-GAS BRAZING OUTFIT

of the flame, a special blower or vaporized benzine is used in general practice.

The soldering apparatus fed with Blau gas shows advantages over ordinary gas soldering, by the outfit's dispensing with any air blower, and being readily transportable. As compared with benzine soldering, the Blau gas process affords the advantage of greater simplicity in operation, and is always ready to work at a moment's notice.

The Blau gas-soldering apparatus shown in Fig. 3 consists of two steel bottles; one of which contains the liquid lighting gas at about 2000 pounds pressure. Small amounts of this are introduced into the second bottle, at a maximum of 30 pounds pressure. This serves as a reservoir and changes it into a gaseous condition. To the upper end of the second bottle are fitted a pressure-reduction valve, a safety valve, pressure gages and tubes connecting with the torches. The whole of the apparatus is readily transportable and the liquid-gas bottle, shown to the left of the figure, is easily replaced by a new one.

Some Remarks on Machinists and Engineers

By W. D. Forbes

There is some advantage in having been a mechanical engineer for five, ten, twenty, or even one hundred years; to look back is interesting, to look forward is more so. The issue of the American Machinist for 2500 will, like its numerous predecessors, be very interesting to the people of that day, but if we could see it now, what would it not reveal? We cannot even frame a hazy idea of its general trend. Changes are, of course, in order, but there seem to be some old-time things that stick to us at all times.

The very first "croak" I can remember in the machine shop was the foreman swearing that all good machinists were either worn out or dead; he would assert, "You cannot get a man who can tap a hole straight or do anything unless you stand over him," and today the same song is being sung.

Is Technical Training All that's Necessary?

In going about I often wonder if the present world of mechanics really believes that such technical training as I received is all that is necessary, or whether such training is made more valuable when coupled with the practical machine-shop work which I was required to do before I could obtain the title of mechanical engineer. In talking with some mechanical engineers who are nominal heads of mechanical enterprises, I am rather led to believe that if it were not for the skill of the decried machinist, many of these concerns headed by mechanical engineers of four years' technical school study would go out of business. In some cases I can clearly see how it is only the inertia of previous engineering ability coupled with the love of the actual manual productive work of the shop of those who established the business, that keeps things going.

I also wonder if in the year 2500 such a mechanical classic as Chordal's Extracts will not have become a sealed book to machine producers. I do not call a machine producer an engineer, any more than I would call the manufacture of iron bedsteads an engineering undertaking, nor can I call a man a mechanical engineer simply because he has taken a course at a school of mechanical engineering, but I am ever ready to do so even if the man has never made a course of study, if his works in the engineering world prove him worthy of the title.

What Constitutes a Mechanical Engineer

The delight of scheming out mechanical ways to produce results and then seeing them carried out, or carrying them out one's self, certainly cannot be for those who are not absolutely proficient in the use of every type of machine and tool, and who do not know every operation and every form of cutting tool and all the peculiarities of material, cutting speeds, lubricants, and the value of properly holding the work. Chordal brought all this out in a way which has given no end of pleasure to hundreds, and the world owes the American Machinist a debt of gratitude for having brought him forward.

It does not worry me much as to what the standing of mechanical engineers will be in the future, as I am a firm believer that all things right themselves after a while, provided people kick enough, but even today it galls me a little to listen to a man whose diploma as a mechanical engineer is dated 30 years after mine, talking in a way which clearly proves he has not started on the real road of mechanics, to hear him talk of "boring a hole with a drill in hardened steel," and when he showed me how he was going to do it, to find that it was only luck that he did not lose a couple of fingers. But I do delight in hearing a graduate of two weeks' standing say that he does not know anything about mechanical engineering as he has only just graduated, and he wants to get into a shop for at least two years. You may depend upon it he had no trouble in getting what he wanted.

The Good-machinist Question

Returning to the good-machinist question: Of course, if we call every man who is in a machine shop a machinist, you will find a small percentage of skilled machinists. The use of the jig presupposes two things; unskilled labor in its use and very skilled labor in its production, or to put it in another way, a little brains leavens the whole mass of good, low-priced production. It would spoil the entire idea if the jig were to be used by a very skilled man. As to the accuracy of the machinist of today, the present machine tools permit what was almost unattainable 30 years ago, if not quite so, and if mechanics advance as all other things do, it is only to be expected that this will go on until the question of atmospheric conditions will be the determining factor in keeping to standard. Take in the matter of grinding; the first built-up emery wheel I ever saw or heard of smelt like an old shoe afire, when you used it. It was looked upon by many shop men as a most dangerous thing to have about, its rotative speed made it so, they said, and that anyway the grindstone was far better as you could not get an edge on a tool without burning it, with an emery wheel.

Not long ago I saw a crank pin 1½ inches long, 1¼ inches diameter finished in less than ten minutes with an emery wheel, and there was no lateral travel of either the crank pin or the emery wheel. I can imagine what some of my old bosses would have said to me, if I had had brains enough to suggest this 25 or 30 years ago, or even I think 10 years ago there would have been a smile all around.

I ran night schools for a certain city for many years with intense enjoyment, and I hope with some good results to the pupils as well as to myself. In getting instructors for night work, I was several times fortunate enough to get men, and one I have in mind particularly, who had served apprenticeships as machinists before they went to the technical school. We had to keep enlarging the accommodations for the classes which they had in hand, and it was a very important engagement that prevented the scholars being on hand every night. There was no necessity of discipline, that went by itself.

The Mechanical Engineer vs. the Civil Engineer

The mechanical engineer is not very well recognized as a professional man in America, but he is coming to his own by and by. I got myself into a peck of trouble with my civil engineering friends by speaking out in meeting. I, of course, knew that the gentle art of killing people was several years ago the most prominent business of the day, and that military operations needed a military engineer, but when they got to doing peaceable things, the man who operated things was called a civil engineer in counter distinction to his military brother, and civil engineers got into the business of building dams, waterworks, railroads, bridges and canals; but my own personal experience, I said, seemed to show that civil engineers figured up something, giving a lot of cubic feet of material, and figured up how much something was going to cost, then they hired a good Irish con-

tractor who undertook the work and carried it along, and it was carried along by the work turned out in the shape of steam shovels, rock drills, boilers and engines, which were entirely the product of mechanical engineers, but when they got through, the civil engineer's figures were anywhere from 100 to 600 per cent. from being correct. Of course, a civil engineer cannot see into the ground, and the weather cannot always be counted on, but it seemed to me that instead of being the "dog" a civil engineer was the tail of the profession of engineering.

I know some first-class civil engineers who do not figure as above, but they have either been practical contractors or practical mechanical engineers before they took up civil work. I am not at all asserting that we should be content with the way we are now turning out first-class machinists. I have my own notions how this can be accomplished, but it would be out of place to explain the matter here, but there is an unfortunate sentiment today and it is a just one, that the good man is not getting a fair return for his skill when compared with the common man. In other words, a three-dollar machinist if taken as a standard would make many men worth 12 dollars a day; the trouble being that we are over-paying our poor men and under-paying the good men, and the fact that some associations of workmen want people to believe that all the apples in the barrel are the same and should be paid for at the same price is deterring men from taking up the machinist's trade, and this is greatly to be deplored.

Repair of Machine Tool Parts by the High Pressure Oxy-Acetylene Torch

By Henry Cave

Users of machine tools who have experienced the long delays so frequently attending the obtaining of spare parts for their machines to replace broken ones, and the difficulty of fitting the new parts when received, will be glad to learn what has been accomplished by the Autogenous Welding Equipment Company, of Springfield, Mass., with the Davis-Bournonville high-pressure oxy-acetylene torch.

This system makes use of the high heat value of acetylene. The heat being concentrated into a small space by combining the acetylene with pure oxygen in a special form of torch, the oxygen being obtained from a supply compressed in a cylinder. In this way, the gas does not have to spread out to obtain the necessary proportion of oxygen from the air, resulting in such concentration of heat as to produce a flame with a temperature of 6300 degrees Fahrenheit, which is equal to that of the electric arc.

The heat is sufficient to fuse any metal locally without materially heating the surrounding parts, and in this way the metal at cracks and breakages can be fused together or metal can be added to replace wear.

One might consider that all these things could be carried out by brazing, but this latter treatment of steel does not make a very strong job, and it is a well-known fact that, though a cast-iron braze will not break again in the same place, the surrounding metal is so weak that it will break just outside of the joint if subjected to much strain, and has nothing like the strength it had before treatment.

This is not the case with welding cast iron, as is well shown by the test piece, Fig. 1, which broke through a flaw in the weld at 25,000 pounds per square inch, which is very close to the maximum strength for gray iron in tension.

One of the great points of superiority of the welding process over brazing is the possibility of building on metal so that bosses and other desired changes of design can be carried out, and parts that are too weak can be reinforced in a satisfactory manner. This has been done in

REPAIRS MADE BY OXY-ACETYLENE PROCESS OF WELDING

the case of the screw-machine slide shown in Fig. 2. Several of these having broken as indicated by the white line in the illustration, were replaced by new ones at great expense. They then tried having them welded with great success, metal being added in the corners *X X* as this appeared to be the weak part, thus making them even better than new ones, as they were much stronger than the replacement.

A good illustration of the strength of steel welds is shown in Fig. 3, two pieces of 1½x5/16-inch bar stock being welded together, the end then being hammered out cold until it split as can be seen. This took place away from the weld after the total width had been increased three-quarters of an inch.

The screw-machine chuck shown in Fig. 4 shows the enormous saving that

results from the use of this process on steel parts, the jaw having been broken off completely, and the cost of welding it on was negligible, to say nothing of the saving of time, as a firm not having more than one of a size may be held up in the middle of a job for several days and in the meantime might have to start the machine on another job, thus having to "set up" again when the new chuck is received, and make all adjustments over again.

Fig. 5 shows to what extent this process can be used in making up plate and sheet-metal parts, and all who have experienced the numerous breakages of the light cast-iron gear covers usually supplied will appreciate the advantage of this one. All parts are made from steel, the bosses being welded as well as the supporting brackets on the ends.

Drip pans can also be made up of steel plate, the corners being welded. This would be a considerable advantage on certain classes of machines, where breakages frequently occur.

The satisfactory welding of the four spokes marked in the illustration of the gear shown in Fig. 6 saved a large factory considerable loss as the machine from which it was removed was pressing out blanks on which a number of succeeding operations had to be performed, with the result that a number of machines were held up by this one breakage.

The frequency with which press castings are broken is shown by the fact that two were received at one time from different places. These are shown in Fig. 7, one having been doweled together at considerable cost; but this form of repair proved unsatisfactory, as though the dowel stood the strain, the parts "worked," causing the disalinement of the punch and die. The parts of the other one are shown prepared for welding. This is done by chipping away the metal so that when the parts are placed together a 'groove of about 90 degrees angle will result. This chipping is done so that, though the metal on the center is brought to a sharp edge, a portion of the old break is left at three outside points so that the parts will "register" together and thus keep the alinement. The three points left for this purpose are clearly seen at *A A A*.

This latter casting is shown welded in Fig. 8, and the amount of metal added to insure sufficient strength can be seen. That the strength is ample is proved by the fact that the parts are still in operation, though it is some time since the work was carried out. It is often possible to save parts from which pieces have been broken and lost, as the missing parts can either be built in, drop by drop, or else a pattern can be made and a new piece cast and welded in, or possibly a piece can be machined out to fit. This latter was done in the case of the triple air-hoist cylinder shown at *A*, Fig. 9, the part being welded in and then rebored. The places shown in white lines on the other cylinders were also welded, but the original pieces were available for replacement. It can, therefore, readily be seen that considerable saving may be affected by the use of the oxy-acetylene process in connection with machine shops and it is an actual fact that hundreds of thousands of dollars worth of parts are being annually thrown on the scrap heap that could be saved by this process, to say nothing of the large savings indirectly resulting from lessening the time the machine is unproductive.

Forthcoming Meetings

International Association for Testing Materials, fifth congress, Copenhagen, Denmark, September 7-11.

International Association of Machinists, biennial convention in September, Denver, Colo.

Brotherhood of Railway Carmen, biennial convention in September, Atlanta, Ga.

National Machine Tool Builders' Association, fall meeting, October 12 and 13, New York City. P. E. Montanus, secretary, Springfield, Ohio.

Business Items

L. H. Gilmer & Co., manufacturers of the Gilmer endless belts, are taking larger quarters at 57 North Seventh street, Philadelphia, Penn., in order to meet their growing demands.

The Garwood Electric Company announces that it has appointed the Charlotte Contract Company, Charlotte, N. C., and the Atlanta Brokerage Company, Atlanta, Ga., as its selling agents for the States of North and South Carolina and Georgia respectively.

Alfred J. Thompson, who since 1893 has devoted his entire time to the sale, installation and operation of American machinery in Latin American countries, has formed a selling organization under his own name at 71 Broadway, New York City, to look after business in that rapidly developing section.

Business Opportunities

The Brush Runabout Company, Detroit, Mich., is to erect a new plant.

The Jones Paper Box Company, Columbus, O., is to erect a new factory.

The Santa Fe road is to erect a large roundhouse at Somerville, Tex.

The Columbus Bolt Works, Columbus, Ohio, will erect a new building.

The Bullard Car Door Company, Birmingham, Ala., will erect a large plant.

The Massachusetts Box Company, Leverett, Mass., is rebuilding its factory.

The Maverick Mills Company is to erect large cotton mills in East Boston, Mass.

Brown & McColley, Winchendon, Mass., are to have a new factory erected.

The Benicia Iron Works, Vallejo, Cal., is to erect several new factory buildings.

The Wickman Wire Works, Howell, Mich., is to build an addition to its factory.

The Automatic Hat Cabinet Company, Minneapolis, Minn., will erect a large plant.

The Twin City Separator Company, Minneapolis, Minn., will erect a new factory.

The Corbin Screw Corporation, New Britain, Conn., will soon erect a new building.

The Chas. P. Linbert Company, Holland, Mich., has completed an addition to its plant.

The Autopress Company, College Point, N. Y., is erecting a large addition to its plant.

Jas. Lee Sons & Co. are erecting a large addition to their plant at Bridgeport, Penn.

The Parlin & Orendorff Plow Company, Oklahoma City, Okla., will enlarge its works.

The McKinnon Chain Company, Buffalo, N. Y., will erect a large plant in that city.

The Carnegie Steel Company will erect a new steel car-wheel plant at Homestead, Penn.

The Central Closet Manufacturing Company, Holland, Mich., is erecting a new factory.

The Holland Gelatine Works, Holland, Mich., have built a large addition to their plant.

The J. H. Ladew Company is planning to erect a large leather factory in Newark, N. J.

The New Castle Leather Company, Wilmington, Del., is to build an addition to its plant.

The New Process Rawhide Company, Syracuse, N. Y., is to erect a new factory building.

The American Cork and Seal Company is to build a new factory in Philadelphia, Penn.

The Oakland Motor Car Company, Pontiac, Mich., is erecting five factory buildings.

The Buck Explosive Company, a new concern, is erecting a plant in Reese Hollow, Penn.

The Atlantic Tile and Faience Company, Perth Amboy, N. J., is erecting a large new plant.

Active work on the addition of the Bruner wrench factory, Chrisman, Ill., has been started.

The Badger State Tanning Company will erect an addition to its plant at Sheboygan, Wis.

The Southern Iron and Steel Company, Gadsden, Ala., is building a large plant in that city.

The Santa Fe Road is to erect a new machine shop, car shop and planer house at Wellington, Kan.

The Lehigh Valley Railroad will build a new roundhouse at its Coxton yards near Pittston, Penn.

Sprake & Shonk, Plymouth, Penn., manufacturers of grease cups, are enlarging their plants.

The Detroit Hoist and Machine Company, Detroit, Mich., is erecting a large addition to its plant.

The Wausau, Wis., Canning Company will erect a canning factory at Marathon City, Wis., this fall.

The Howard Safe and Vault Company, Atlanta, Ga., is to erect a large plant on the outskirts of the city.

The Quaker City Cab and Taxicab Company, 1217 Vine street, Philadelphia, Penn., is erecting a new garage.

Construction of a new roundhouse for the New Orleans & Northwestern shops, Meridian, Miss., has been started.

The Malleable Iron Fittings Company's plant in Brantford, Conn., is to have an addition built to its steel foundry.

Luzerne Manufacturing Company, Luzerne, Penn., is now building a new addition to its foundry and machine shop.

The Kanawha & West Virginia Railroad Company is preparing plans for building repair shops at Charleston, W. Va.

L. O. Thompson, Luzerne, Penn., expects to rebuild his machine shop this fall and will equip it with up-to-date machinery.

The Warner Electric Company, Muncie, Ind., a new company, will erect a plant for the manufacture of electrical appliances.

Holden & Leonard, Bennington, Vt., are erecting a large addition to their mill and will add many new motor-driven looms.

The American Locomotive Company is to enlarge its Brooks plant, Dunkirk, N. Y. and is to install new machinery.

Handy Bros., owners of the box factory in

Bay City, Mich., recently destroyed by fire, are preparing to erect a new plant.

The Bibb Manufacturing Company, Columbus, Ga., is to purchase additional machinery for several of the company's mills.

The Bruon Cooperage Company, Sunderland, Vt., are erecting a new cooperage and steam plant, installing all new equipment.

Construction work on the new International & Great Northern roundhouse and machine shops, Taylor, Tex., has been started.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E. G. Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Wanted—One draw bench. Address with particulars, Box 582, AMERICAN MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—500 pounds channel iron ⅞ inch wide, ½ or ¾ inch deep, ¼ inch thick. John Whisler, Gibson, Iowa.

Wanted—To purchase drawings of a really first-class back knife gauge lathe. Offers to Box 572, AMERICAN MACHINIST.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Manufacturers considering active representation in Philadelphia territory. Address "Mechanical Engineer," AMER. MACHINIST.

Dies designed, all kinds, with cost of making; practical working drawings; send sketch of model. Box 548, AMERICAN MACHINIST.

We design and build light machinery, including fixtures, jigs, tools, punches and dies, and model work. The Matson Machine Co., Bethel, Vermont

Special machines for reducing the cost of production designed; inventions developed to a practical and commercial basis. Benj. Brownstein, mechanical engineer, Trenton, N. J.

Have well equipped machine shop centrally located in New York City; would like to meet party with good specialty and some capital. Box 600, AMERICAN MACHINIST.

Lathe and machine work of every description, patterns, gear cutting, screw machine work, iron, brass and aluminum castings. The Sipp Electric & Machine Co., Paterson, N. J.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

By manufacturer, agents or dealers to handle oil cup of improved design; excellent cup and can be sold at a low price; large field for the sale of this device among machine shops, mills, etc. For particulars address Box 612, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Foreman wishes to change; experienced in modern machine-shop practice and capable of producing work at low costs; interview; references. Box 607, AMERICAN MACHINIST.

Systematizer and accountant desires position; experienced, energetic and capable; can install modern system of accounting and production that will produce results. Box 556, AMERICAN MACHINIST.

A draftsman with seven years' experience on automatic machinery and tools for interchangeable parts desires a situation. Capable of taking charge of a small office. Any location satisfactory. Box 576, AMER. MACHINIST.

Wanted—Position as superintendent, assistant or general foreman, thoroughly conversant with modern up-to-date methods in tool design and manufacturing small or medium interchangeable work; executive ability; can produce results, quality and quantity at minimum costs; at present employed in responsible position. Box 591, AMERICAN MACHINIST.

ILLINOIS

A practical mechanic with 17 years' experience on accurate work, desires to communicate with company requiring the services of a superintendent or assistant superintendent, having exceptional executive abilities in handling help, a good organizer, also able to produce work at a maximum output with a minimum cost. Box 578, AMERICAN MACHINIST.

INDIANA

Superintendent of forge shop on shape or drop hammer work; costs and weights from drawings; contract preferred; 20 years' experience. Box 569, AMERICAN MACHINIST.

MASSACHUSETTS

Superintendent, wide experience in manufacturing, desires change. Box 525, AM. MA.

Position of responsibility wanted in manufacturing plant making mechanical or electrical apparatus. Technical graduate; speak German. Age 31. Ten years' experience as chief draftsman, salesman, and cost specialist. Can devise cost reducing methods and reduce costs per unit. Box 580, AMERICAN MACHINIST.

Assistant superintendent or tool-room foreman; 35; technical, practical; 15 years' experienced toolmaker, designer of modern labor-saving tools, jigs and fixtures, for economically producing interchangeable parts, for light, high-grade machinery; executive ability and systematizer; best references; open for engagement October 1. Box 616, AMERICAN MACHINIST.

MICHIGAN

Mechanical engineer, technical graduate, energetic, aggressive and systematic, 16 years' experience as designer, chief draftsman and engineer; conversant with both mechanical and structural work. Desires responsible engineering position with first-class firm. Box 586, AM. MA.

NEW JERSEY

Mechanical draftsman wishes position. Address Box 617, AMERICAN MACHINIST.

Position wanted by technical graduate with experience on general automatic machinery and printing-press design. Box 608, AM. MA.

Mechanical engineer, 28, first-class designer and draftsman of thorough shop experience, desires responsible position; now employed. Box 604, AMERICAN MACHINIST.

NEW YORK

Draftsman, experienced, seeks position. Box 584, AMERICAN MACHINIST.

Draftsman with long experience, machine and structural, wishes position. Box 596, AMERICAN MACHINIST.

Mechanical draftsman, young man, four years' experience, desires position. Box 594, AMERICAN MACHINIST.

Draftsman presently employed on pumps, desires change; long experience; technical graduate. Box 597, AMERICAN MACHINIST.

Draftsman, graduate mechanical engineer. Experienced in design of general and special machinery; shop practice. Box 577, AMER. MA.

Designer, experienced on automatic and special machinery, capable of taking charge of work, desires responsible position. Box 583, AMERICAN MACHINIST.

Shop and foundry superintendent desires change; cost reducer, energetic, successful with men; experienced on interchangeable and jobbing work. Box 598, AMER. MACH.

First-class foreman diemaker desires change; good organizer, and a hustler with executive ability; an expert on all classes of accurate diemaking, etc.; excellent references. Box M, AMERICAN MACHINIST.

Technical graduate, 29, seven years' general experience in shop, foundry and drawing room, desires position connected with air compression or pumping machinery. Box 610, AMERICAN MACHINIST.

Position as foreman of machine shop or tool room by an American; age 30; married; 14 years' experience as machinist, toolmaker, draftsman and foreman; technical education; present position, foreman of machine shop. Box 605, AMERICAN MACHINIST.

Wanted—Position as master mechanic or superintendent, vicinity of New York; exceptional mechanical and executive ability; thoroughly familiar with estimating and piece-work systems; expert in sheet-metal goods and tools for same; employed at present as master mechanic large works, but desires change. Box 554, AMERICAN MACHINIST.

Wanted—Position of responsibility by mechanic having 16 years' experience as tool maker, designer of special machinery including hobbing machines for spur, helical and worm gears; also jigs and other labor-saving appliances. Am at present shop superintendent. Familiar with modern shop practice, equipment, system, etc. Successful handling help. Box 585, AMERICAN MACHINIST.

Factory manager; $3500 man wants an opening; can fill any position man of that price should be capable of filling in mechanical manufacturing line; worked up from apprentice to assistant superintendent with one concern; capable of handling 5000 men; can start at once; best references from present employer; executive ability and personality marked. Box 595, AMER. MACH.

OHIO

Wanted—Position with a small progressive firm that can place a capable executive now employed, whose 13 years' experience has been very extensive in machine shop, tool room, cost work, etc.; good technical education; age 30, married; A-1 references. Address H. G. Arthur, Massillon, Ohio.

PENNSYLVANIA

Progressive young pattern shop foreman wants position; experienced in pattern shop costs and systematizing. Box 593, AM. MA.

Cost accountant, thoroughly experienced in the installation of modern cost and storeroom systems, desires change. Box 602, AMERICAN MACHINIST.

Practical machinist; 22 years' experience on road and in shops, desires position as demonstrator of machine tools, willing to spend part of time on erecting floor in shop. Box 615, AMERICAN MACHINIST.

Practical mechanic, ten years' shop experience and six years as draftsman and designer; special machines, tools and dies; have had charge of typewriter experimental department; at present employed as designer on similar work; have technical education. Box 609, AMERICAN MACHINIST.

TENNESSEE

Superintendent with wide practical manufacturing experience, up-to-date on modern methods and factory costs. Box 558, AM. M.

WISCONSIN

Technical graduate, American, 28, married, will be open for a position November 1; experience in foundry, pattern and machine shops; also erecting and operating of engines and turbines. Box 606, AMER. MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CALIFORNIA

Wanted—Superintendent capable of taking charge of machine, boiler and blacksmith shops and foundry devoted to manufacturing oil-well tools and machinery and repairs of same. He must be experienced in getting tools out at a cost that will allow close competition, and keep the general shop expenses down; shop is located in a thriving California town of 10,000, with an abundance of schools and churches; a good man has an opportunity to increase the business, cut down the present shop expenses and increase his salary; state capabilities and give references. Box 592, AMERICAN MACHINIST.

CONNECTICUT

Wanted—An expert mechanical engineer, one experienced in auto motors preferred; a rare opportunity for a young man of practical experience who can prove worth. Box 613, AMERICAN MACHINIST.

Tool and die makers wanted; first-class men, experienced on jig and fixture, for small interchangeable parts, also die makers on leading, cut and draw, and punching dies; steady employment. Apply to the Yale & Towne Mfg. Co., Stamford, Conn.

Wanted—First-class die sinker for dies on heading presses, drop hammers and power hammers capable of taking any ordinary piece and making dies to reproduce it. Give experience, age, etc., and salary expected. Location is pretty New England village where living is cheap. Box 543, AMERICAN MACHINIST.

ILLINOIS

Draftsman wanted for jigs, tools and general automobile work. Buda Foundry & Mfg. Co., Harvey, Ill.

Wanted—A draftsman to work on drawings for plumbers', gas and water supplies and also

Manufacturing Laboratory at Neubabelsberg

A German Commercial Proposition, Employing 120 Men and Carrying on Technical Investigations to Aid in Manufacturing Work of Its Founders

BY HENRY HESS

The view that we present as Fig. 1 is not of some landed proprietor's country estate in its surrounding park, but of, undoubtedly, the most interesting commercial laboratory in the world. The main and subsidiary buildings all serve a most utilitarian purpose, the conducting of experimental work for a series of industrial plants devoted to the manufacture of fire-arms, cartridges, powder, and the well known "DWF" or "Hess-Bright" ball bearings.

This plant is located about an hour's railway journey outside of Berlin, Germany, on the river Havel, in picturesque Neubabelsberg. Possibly the fact that at Neubabelsberg are located the pleasure palaces of Prussia's kings had its influence on the architect in laying out the grounds and departing from the usual prosaic exterior of factory buildings. Or again, he may have considered that the unusually interesting work to be carried on here should be fitly housed within an interesting shell. In any event the result is most pleasing, as shown by the illustration.

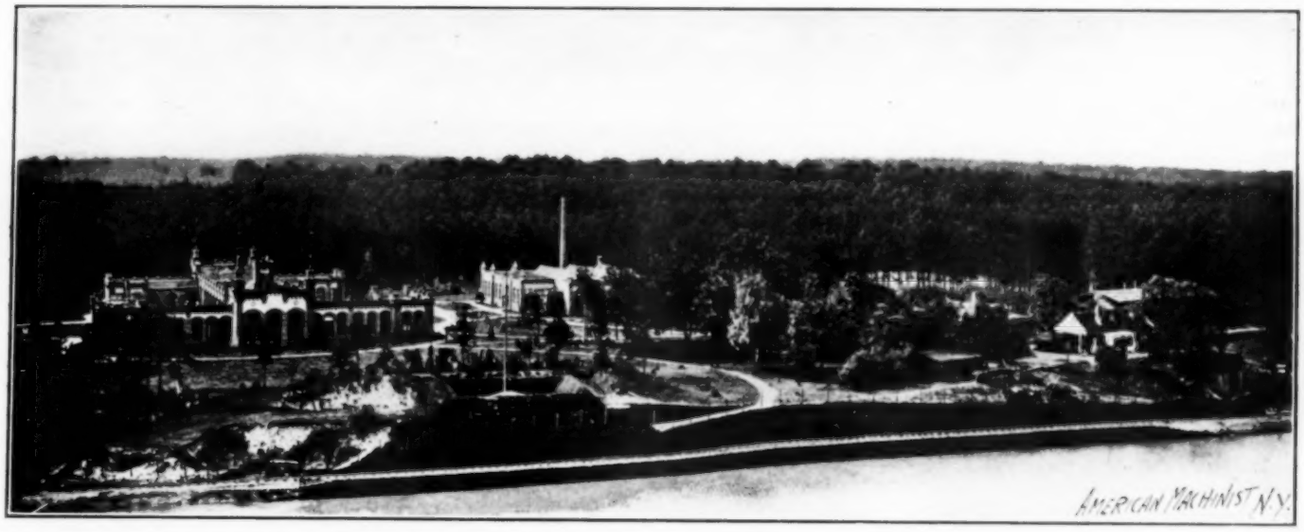


FIG. 1. THE CENTRAL LABORATORIES FOR SCIENTIFIC INVESTIGATION AT NEUBABELSBERG, GERMANY

FIG. 2. THE LABORATORY FOUNDRY

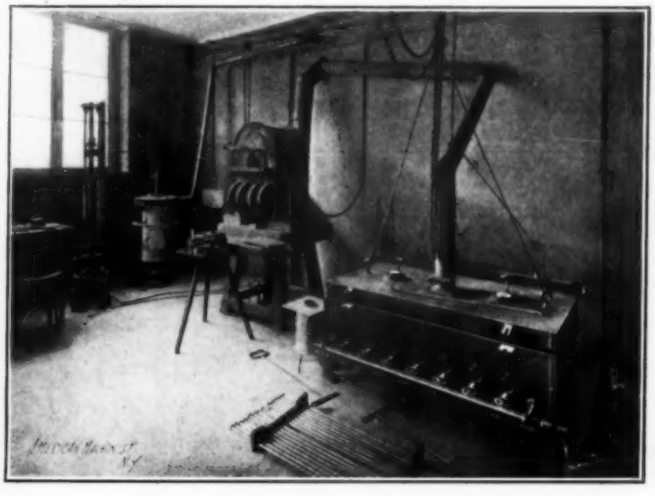


FIG. 3. THE LABORATORY, TEMPERING AND ANNEALING FURNACES FOR DEEP TESTS

Founding of the Laboratories

Seven years ago one of the chief men, now dead, closely identified with the manufacture of powder and other high explosives, Dittenhofer by name, conceived the idea of disassociating the highly complex research work connected with the development of modern explosives from the work of manufacture, by relieving the investigators of all of the pressure and demand for immediate commercial results incidental to their direct connection with the factory itself. These concerns, The United Köln-Rottweiler Powder Factories, The Nobel Dynamite Trust, and the German Small Arms and Ammunition Factories (DWF), and the latter's main subsidiaries, the Arms Factories, Mauser, Oberndorf, the Cartridge Factories, Karlsruhe, the Fabrique Nationale D'Armes de

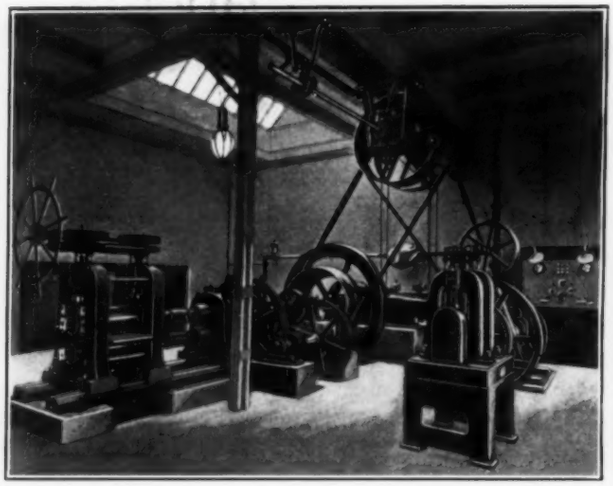


FIG. 4. THE ROLLING-MILL EQUIPMENT OF THE LABORATORY

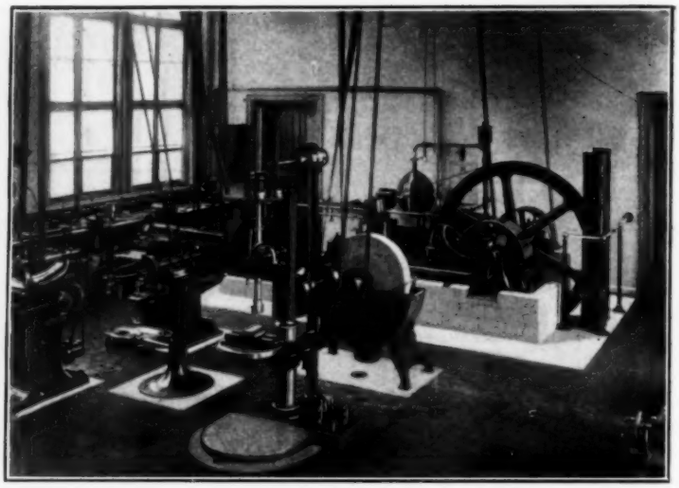


FIG. 5. A CORNER OF THE MACHINE SHOP

Guerre, Belgium, etc., in 1898 founded this laboratory as a limited-liability company, under the name of "The Central for Scientific Technical Investigations," with a paid-in working capital in cash of 2,100,000 marks.

Although not devoted to the turning out of any commercial product, and restricting its work entirely to scientific research along lines tending to the greater efficiency of the product of those interested founders, the name of a manufacturing laboratory may be fitly applied, when it is taken into consideration that under the guidance of Professor Stribeck there are employed two managers, 25 engineers, chemists and administrators, and 90 workmen.

The chemical division concerns itself chiefly with investigations of powders and high explosives. While this is highly interesting to the chemist, a description is foreign to the field of the AMERICAN MACHINIST; but the equipment and work of the physical and metallurgical research departments, chiefly in the interests of the DWF and the Hess-Bright Manufacturing Company, of Philadelphia, Penn., presents much that is worth the serious attention of your readers.

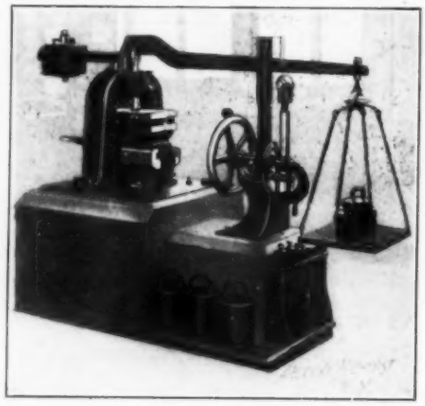


FIG. 8. MACHINE FOR COMPRESSING COPPER TEST PIECES TO DETERMINE GAS PRESSURE IN FIREARMS

FOUNDRY, ROLLING MILL, MACHINE SHOP AND METAL-TESTING LABORATORY

In the plant there is, Fig. 2, a well equipped foundry with various furnaces for steel and copper alloys, drying ovens, etc. Some of the heating, tempering and annealing furnaces and ovens and a drop for hot tests are shown in Fig. 3. A rolling mill, of which a corner is shown in Fig. 4, is an essential part of the equipment. That a machine shop is needed is self-evident; Fig. 5 shows a part of it. That considerable attention is devoted to various physical tests is to be expected. Fig. 6 shows the larger room containing eight machines for tensile and compression loading, the smallest of which is good for 660 pounds and the largest for 550,000 pounds. The other machines are for hardness testing, impact weighing and measuring, etc.

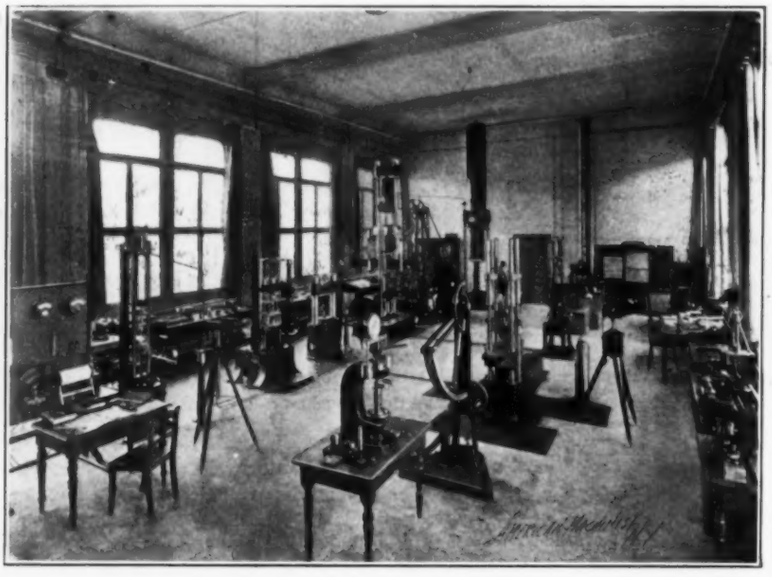


FIG. 6. THE LABORATORY FOR PHYSICAL TESTS ON METALS

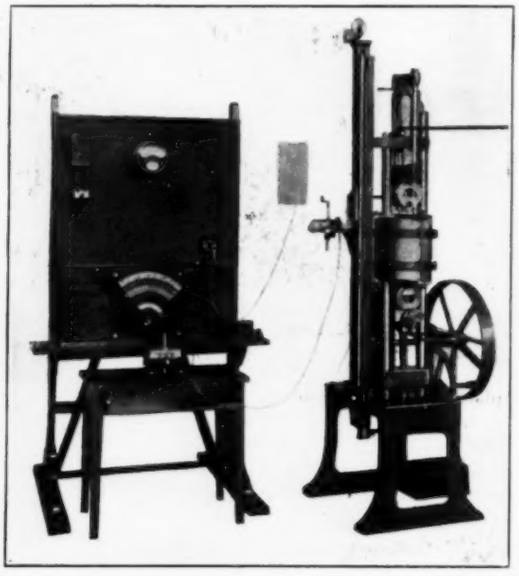


FIG. 7. APPARATUS FOR TENSILE TESTS ON HOT SPECIMENS

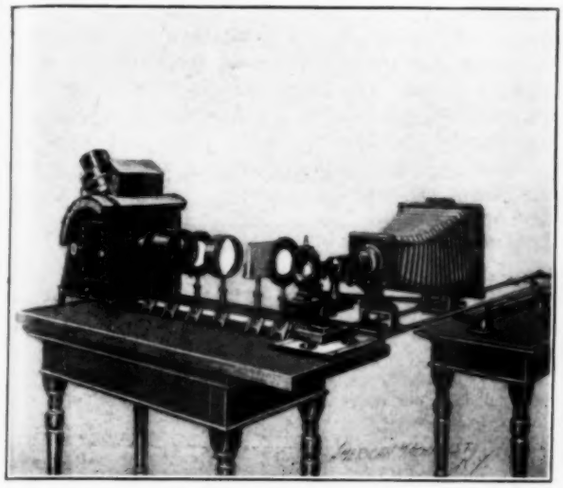


FIG. 9. MICROPHOTOGRAPHIC OUTFIT

FIG. 10. CORNER OF LABORATORY DEVOTED TO PREPARATION AND STUDY OF SPECIMENS UNDER MICROSCOPE

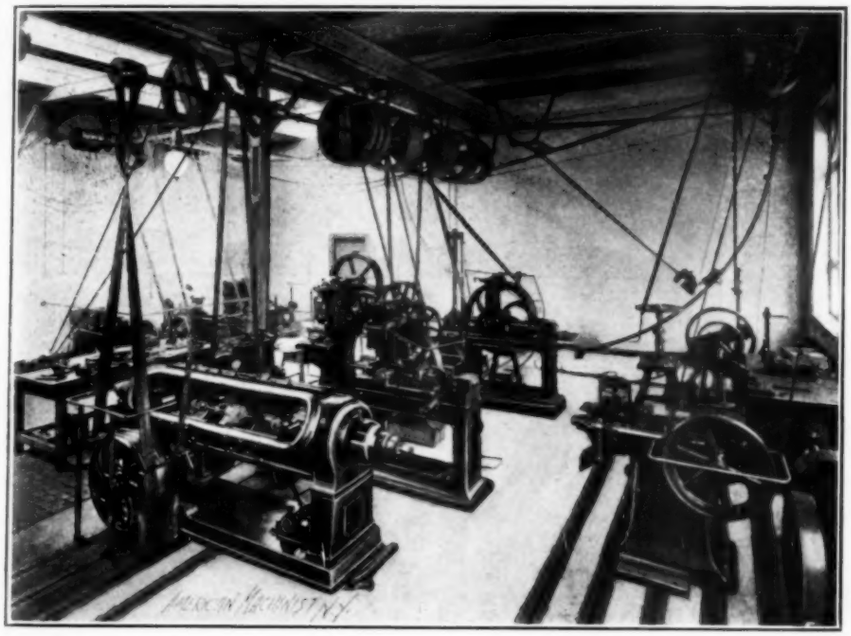


FIG. 11. THE CARTRIDGE-MAKING PLANT

For certain work knowledge of the strength of metals, when heated, is most important. In Fig. 7 there is shown a machine for hot tensile testing. The test specimen is arranged vertically and surrounded by an electrically heated furnace. Curves are drawn automatically to indicate the full behavior under various temperatures; the electrical furnace gives opportunity for a large heating range combined with great constancy at any degree of heat wanted.

Laboratory for Testing Gas Pressure in Firearms

The method for determining the gas pressure in high-powered guns most generally accepted of artillerists is the compression or indentation of copper cylinders arranged in the gun itself, combined with the production of similar results on duplicate cylinders on a testing machine. The readings of this machine thus give the static pressure required to produce compression similar to that produced by the

FIG. 13

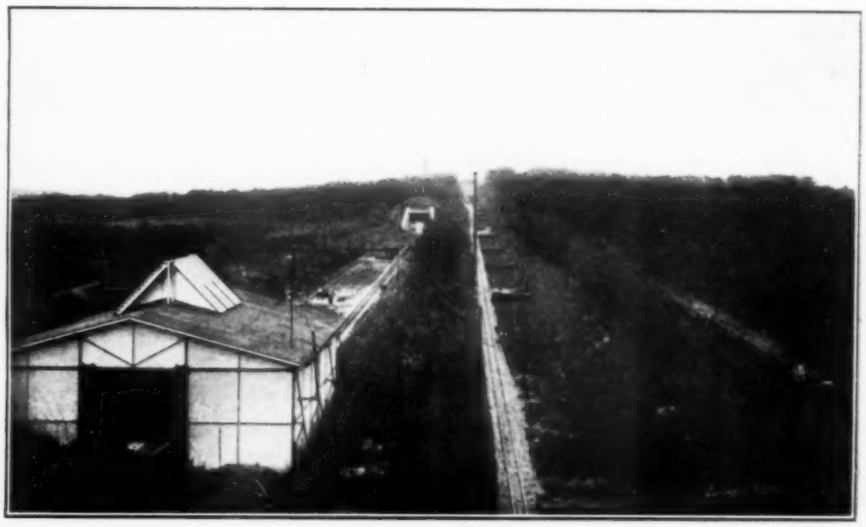


FIG. 12

TWO VIEWS OF THE RIFLE RANGE AT FEUTHEN

gas pressure within the gun. Fig. 8 shows the machine used for this testing.

Microscope and Microphotographic Equipment

The modern engineer interested in his materials does not content himself with the older chemical and physical tests, but calls in the microscope to view his specimens and then preserves a permanent record of what this shows him by using a microphotographic outfit, of which a most perfect example is shown in Fig. 9. The microscopist is shown at work in Fig. 10 with his photographic record beside him for comparison. A helper grinding specimens for the microscope is conveniently at hand.

Cartridge-making Plant and the Rifle Ranges

The drawing of brass cartridge shells for small firearms is much influenced by the composition and temper of the alloy. The conclusion drawn from the behavior of the metal under tensile and other tests and from knowledge of its chemical characteristics is put to actual test before passing the material to the manufacturing plant. For such actual test a full cartridge-making plant, Fig. 11, forms part of the outfit of this laboratory. An interesting detail of building construction here is the slotted floor admirably adapted for the temporary or permanent bolting down of machines.

As the D. W. F. and its subsidiary plants manufacture not only powder and cartridges, but small arms, such as the Borchardt and Luger automatic pistols, and infantry and cavalry rifles, as well as Maxim guns, the laboratory has shooting ranges, illustrated in Fig. 12. These, however, are located at Feuthen, where a range 4000 feet is available. Fig. 13 of the long range gives a clearer view of the frames for determining the trajectory.

Apparatus for Studying the Construction and Action of Projectiles

A room with apparatus for ballistic measurements is shown in Fig. 14. To the layman it seems incomprehensible that anything moving as rapidly as a modern projectile can be seen in its flight and, moreover, seen so plainly that characteristics of its flight at various stages may be studied. The modern photographer, aided by the electrician, makes little of this problem. The outfit that he employs is shown in Fig. 15. A projectile just as it has left the mouth of the rifle and the smokehead are clearly shown in Fig. 16. The bow and stern waves and wake of different projectiles are shown in Figs. 17 and 18.

FIG. 14. THE BALLASTIC LABORATORY

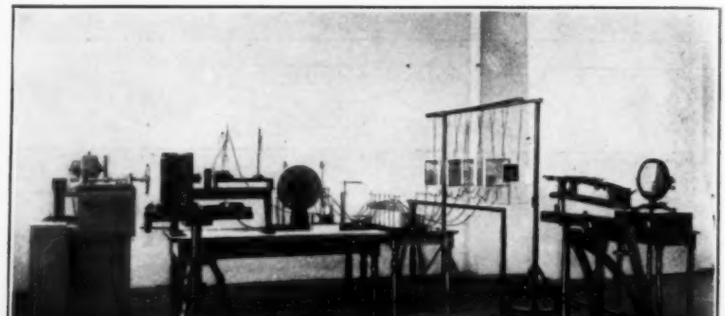


FIG. 15. APPARATUS FOR PHOTOGRAPHING PROJECTILES IN FLIGHT

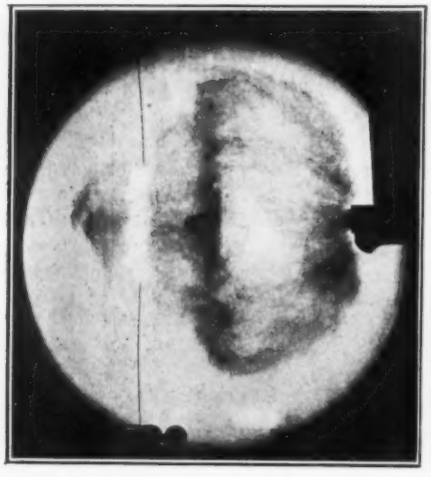


FIG. 16

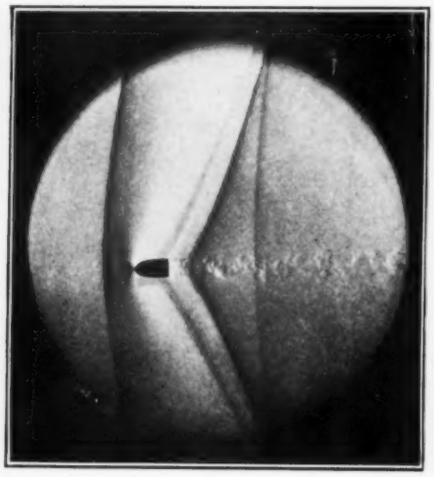


FIG. 17

PHOTOS OF PROJECTILE IN FLIGHT

FIG. 18

Annealing Carbon Tool Steel

By T. Du Pont.

It is very curious to find that although we must heat tool steel and plunge it in water to harden it that the same process will also anneal it. An old toolsmith informed me that if it was heated and allowed to cool until, when seen in a dark corner, it seemed to glow again, and then plunged into water, it would be quite soft.

This point, I take it, is the recalescent point, though why the steel should be annealed by being quenched at this or any other point seems curious. Perhaps some of your correspondents may throw a little light on this feature.

Pneumatic Jam Riveters

By W. T. Sears

For a great many years, the use of air in a compression riveter was considered unsatisfactory with undoubtedly more or less reason, for while the air was easily handled, that is, brought to the machine with little trouble and controlled by simple valves, it was necessary to use some form of lever or reducing motion in order to obtain the necessary riveting pressure without using cylinders of great size or air at very high and uneconomical pressures.

As soon as air is compressed up to, say 1000 or 1500 pounds per square inch, which is the common pressure used in hydraulic riveters, many of the advantages usually connected with an air installation disappear. A cubic foot of air at 1000 pounds pressure costs in power, over 600,000 foot-pounds, assuming it to be compressed under most theoretically favorable circumstances, that is isothermally and without friction, which would, under actual conditions amount to over 1,000,000 foot-pounds, and if it was used similarly to water in a hydraulic tool with no benefit derived from allowing it to expand, it would have no advantages, as regards conveying it to the machine. It would, therefore, cost many times as much as water used in the common way. In fact for both practical and theoretical reasons, the use of such high-pressure air in riveters is never attempted.

A direct acting fixed or stationary riveter for quite a large range of work, in which air at 100 pounds is satisfactorily used, has been on the market for a number of years, but the large size of the piston required makes it impracticable for portable machines, and even on the fixed riveter the cylinder is in the way for a considerable class of work. This leaves the only practicable portable design, one in which as before stated, the heavy riveting pressure is obtained by means of a moderate sized cylinder, in connection with some reducing mechanism which converts the moderate pressure and relatively long stroke of the piston into a heavy pressure and short stroke required for riveting.

Leaving out of consideration the hydropneumatic type of machine in which the riveting pressure is obtained through the well known intensifying principle used in hydraulic machinery, the most familiar designs of pneumatic riveters are the so called toggle machines. These are commonly of two types, Fig. 1 and Fig. 2. *A* is the riveter frame, *B* the center line of dies, *C* the cylinder, *D* the piston, *E* the toggle link connected to the frame, and *F* the toggle link connected to the plunger which carries the movable riveting die. In both of these machines, the toggles straighten out or, in other words, reach a point where the pressure exerted or leverage obtained theoretically runs up to infinity.

Such extreme pressures are of course not actually reached or even approximated, owing to the spring of the different parts, and of the riveter frame especially. This is shown graphically in Fig. 3, in which the curve *AA* represents the theoretical pressure curve exerted by a toggle at different points of piston travel, horizontal distance representing piston travel and vertical distance pressure exerted. Assuming the die first strikes the rivet at point *D*, then the pressure on the rivet would be somewhat along the curve *BB*. These curves are not actually figured, but are near enough for practical purposes of illustration.

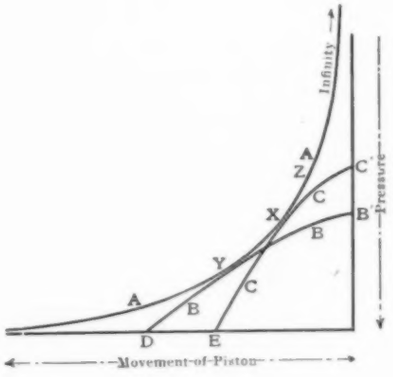


FIG. 3

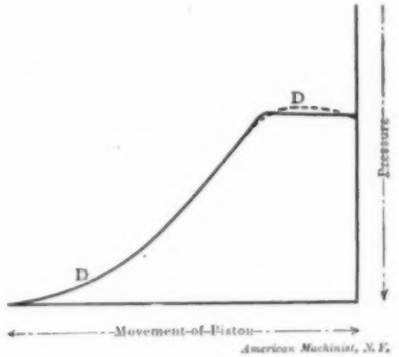


FIG. 4

CURVES OF PRESSURES PRODUCED BY DIFFERENT LINK ARRANGEMENTS

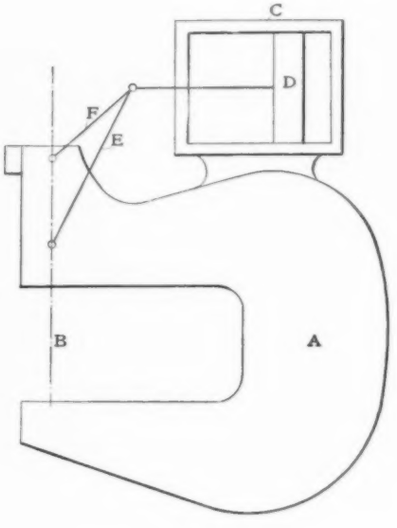


FIG. 1

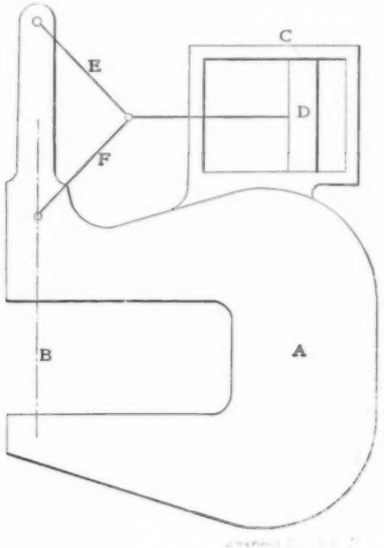


FIG. 2

COMMON TOGGLE RIVETERS

The curve *BB* must of course keep below the curve *A A*, otherwise the riveter would stall. In actual practice this stalling often takes place say, at some place on curve *A A*, as at *Y*, when the riveter must be reversed, and the plunger length shortened by turning the screw die holder. At the next stroke the anvil will be struck later as at *E*, and the pressure curve will run up on some such line as *CC*.

If the die has been shortened sufficiently, the stroke will be completed and the critical point (in this case *X*) passed. From here on the pressure that can be exerted at the dies increases much faster than the resistance or, as shown in the diagram, the curve *A A* rapidly leaves *C C*, and the result is that the piston jumps with a quick movement to the end of its stroke, and the toggle hits its stop with a sharp rap. One of the chief losses in air is due in riveters of this class to the additional strokes taken, for unless there is the same amount of material in the rivet to be upset each time, and the riveted parts of almost exactly the same thickness, the die length must be adjusted often, and it is seldom or never adjusted correctly on the first stroke.

By repeating the strokes and adjusting the die length a little at each stroke, the point *X* can be carried higher and higher

on the pressure line *A.A* with the result, that the final riveting pressure or *C'* is somewhat increased over that obtained on the first stroke, or *B'*. This pressure is always indefinite, although by taking a number of strokes on each rivet the variation is much reduced, and the maximum approximated. Of course the curves *BB* and *CC* are not accurate; they vary with the size of the riveters, the lengths of the rivet, the thickness of material riveted, and the temperature of rivets themselves. The general action is, however, clearly shown, which is that the resistance at first is considerably less than the pressure which can be exerted; that these two quantities approach nearer and nearer (provided we assume the riveter is to exert its maximum pressure) until the variable critical point is reached. Beyond this point the pressure which the machine can exert rapidly increases over the resistance and the machine goes over with a bang, unless it is cushioned in some manner. The final pressure in most cases, is not much more than the pressure at the so called critical point.

This indefiniteness of pressure is one of the main reasons for retarding a more general use of pneumatic riveters, and has prevented their superseding the hydraulic riveter to the great extent they undoubtedly would have done if this weakness had not existed.

While the action has been known and appreciated for many years, it is only comparatively lately that any good mechanical attempts have been made to modify the simple toggle riveter so that a known maximum riveting pressure can be exerted through some considerable distance. The problem has been attacked in several ways, the attempt being to approximate a curve similar to full line *DD*, Fig. 4, and up to date the writer is acquainted with three or four which give or approach this result more or less closely. In any event they come nearer to it than types shown in Figs. 1 and 2.

There are one or two others of such design that they are or could be so arranged as to give this ideal pressure curve, but owing to the manner in which the reduction of motion is obtained, the details of the parts that take thrust cannot be made so as to give satisfactory service at a reasonable cost of manufacture for pressures now demanded for riveting.

Fig. 5 shows one of these machines in which the pressure it is capable of exerting follows very closely along the line *DD* in Fig. 4.

The first action is somewhat similar to the toggle movement illustrated in Fig. 2, and the flattening of the curve at the end of the stoke is due to the movement of the link *G* around the end of link *E*. *F* is the compression link. It is connected to link *G* on one end, and to the plunger that carries the die on the other. *H* is simply the guide link for the system and forces it to move in the desired manner. If there is any serious criticism to be made of this toggle machine, it would probably be as regards the considerable number of levers or links which are used.

Fig. 6 shows a modification of Fig. 1. In this case the links *E* and *G* act as a single link until they reach approximately the position shown in the sketch. At this point, link *G* is stopped, and the links *E* and *F* complete the movement. As they are about the same length, the action while the lower end of link *F* is passing by the lower end of link *E*, gives a very nearly constant pressure for some little distance at the end of the stroke. This is considerably simpler than Fig. 5, and the pressure curve is practically the same; but the use of a jointed link in the manner shown, requires an additional spring or cylinder to control the movement of the link *G*.

Fig. 7 shows a modification which is but very little different from Fig. 1, except that the lower end of link *E* is moved back from the center line of the plunger that carries the die, with the result that the pressure curve does not rise at the end to quite the extent that it does on the type shown in Fig. 1. This curve, referred to before as *AA* in Fig. 3, is somewhat shortened, and the pressure would perhaps stop increasing at some point such as *Z*.

The general outline of the curve would not differ much from that given by Fig. 1. It is somewhat better, however, in that the surplus end pressure has been cut off, but if the stroke were to be continued until the center lines of links *E* and *F* coincide, the same conditions regarding infinity would occur. There is really no very appreciable flattening of the pressure curve at the end of the stroke, which is desirable.

Fig. 8 illustrates an arrangement of links which is very simple. There are no more parts than are used in Fig. 1 and 2, but the pressure curve closely approximates the line *DD* in Fig. 4, the variation being shown by the dotted line. In this device, the theoretical pressure can never reach infinity, for there is no possibility of the links *E* and *F* ever coming into the same line, unless moved through a half revolution, which is far beyond the limit of the stroke of machine. The actual curve follows very closely the one given by the machine shown in Fig. 6.

With a machine which is capable of giving a pressure curve approximately like *DD* in Fig. 4, the one uncertainty of the riveting pressure exerted by a pneumatic riveter disappears, and also the bother of continually adjusting the die length for slight variations in thickness, and other inequalities of the work.

It is simply necessary to be sure that the point of maximum pressure has been reached, and this can easily and surely be ascertained, by means of a signal such as the escape of air or by noting the position of some part of the link system. There is therefore no reason why such riveters should not take the place of, and satisfactorily perform the duty of any hydraulic riveter, especially for moderate pressure of, say, up to 75 or 80 tons, and that this is so is proved by the experience of such machines in many shops.

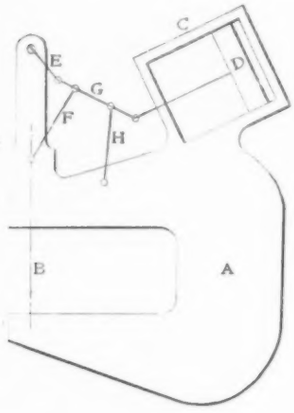


FIG. 5

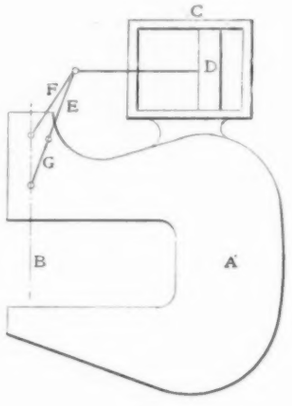


FIG. 6

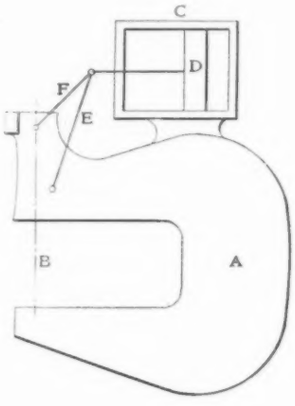
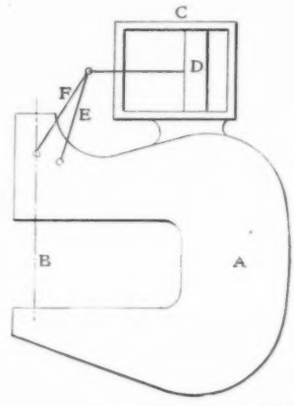


FIG. 7



American Machinist, N.Y.

FIG. 8

FORMS OF MODIFIED TOGGLES TO GIVE DESIRABLE PRESSURE CURVES

All of the above types are or have been patented or illustrated in trade journals and pamphlets, and are used very extensively in the United States and Canada.

In England there seems to be some considerable prejudice against pneumatic riveters, but it is undoubtedly caused largely by former experience with types that give a riveting pressure of varying amount, and not a definite fixed quantity, as is given by riveters of the hydraulic type.

Compressed air in shops is coming to be more and more recognized as a necessity, and the list of operations on which a great saving can be made is increasing rapidly, and for this reason the above article was written. It calls attention to some points regarding riveting by air that are not generally recognized by shop men at large.

Fallacy of the Pedagogical View of Trade Training

By Instructor

"Vocational training is not a public-school possibility for pedagogical reasons. Vocationalizing means securing skill, accuracy and rapidity by repetition until the control is almost automatic. This is deadening to the higher brain centers, and results in arrest. . . . Education has to do with the higher brain centers, not with the reflex system; hence any scheme looking toward automatizing child activities is unpedagogical, and this is what vocational training does. Not until the age of 18 years is vocational training justifiable; hence it is without the range of the public school."

All this was printed in the *Journal of Education*, July 22, from the pen of G. H. Whitcher, superintendent of public schools in Berlin, N. H. He also intimates that to vocationally educate children under 18 is a crime.

Reducing all this to the English language, it means that in Mr. Whitcher's opinion, which is undoubtedly shared by many school teachers, no attempt to teach skill, accuracy, or rapidity should be made until a boy is 18 years old. Of course, that cuts out all use for him around a machine shop, which is really pretty hard luck, seeing that most of our best mechanics began long before they were that age. What a big lot of criminal employers our fathers were! They used to take apprentices at 14 years and younger and let them go out at 18 full-fledged journeymen. My own father began at 11, and was in business for himself at 19. Of course, they did not know any better, poor fellows.

If this idea of Mr. Whitcher's is correct, it must be a bother to the public-school teachers. If they give out problems in arithmetic they must be careful that Johnny does not get too many of them right, for that would indicate that he was securing skill and accuracy on the quiet. I suppose that teachers now-a-days are supposed to teach boys and girls how to do things, but to be careful that they cannot really do them until they are 18 years old.

I have been wondering what was the matter with our young people for some time, but now that I find out I understand that it has been considered a crime to teach them thoroughly for fear that they would acquire skill, accuracy and, worst of all, rapidity, in school.

Our boys come out of school at 18 years hopelessly unskilled in the three R's even, hopelessly inaccurate in arithmetic and rapid in nothing but baseball; in fact, about all the real life in them comes directly from their self-directed play. When they play they repeat, they "automatize"; they pitch the same size ball the same distance hour after hour, day after day, without realizing that their fond parents are criminally negligent in allowing it. They get so that they can get the ball over to first with a skill, accuracy, and even rapidity that applied to shop or business would help this old world along remarkably.

Absurd to Advocate Stopping the Teaching of Skill

If it is absurd, and I think every shopman will agree that it is, to stop the teaching of skill, accuracy and rapidity in the school and on the playground, why stop it in the shop? Possibly, though, our school-teacher friends do not understand just what the requirements of the trades demand in order to produce skill, etc.

I do not know of an operation regularly carried on in a machine shop that demands the routine, "deadening to the higher brain centers" that is necessary to pitch a ball over the plate. There is necessary a long training to train the connection between fingers and brain to make one work with the other to produce results, but this cannot be done except by the doing of a varied class of work. A boy is often set to work to center and turn a barrel of studs. After he has made one right, no doubt our educational friends would say that he had squeezed all the good out of the barrel. I think he has only begun. When he has reached the point where 99 studs out of every 100 are right, then he has learned to make those studs and is ready for another job. This is a different proposition from keeping him on those studs week in and week out. That *is* soul-deadening. No man or boy ever got anywhere who could not stick to a job as long as is necessary to learn to do any machine-shop work well and with fair rapidity.

The Schools of a Generation Ago Drilled

This brings us to just the point that I believe to be the crucial one in the supposed opposition of school and shop. The school method of training back in the days when I went to the country school and scorched my face by a wood fire in the winter, was to everlastingly drill us in our work, and the only things that stick by me today are those things that were thus drilled into me. The shops taught their boys in the same way. Today the schools, except for a few back numbers, that I thank the Lord are still with us, side-track this drilling and teach superficially for fear that they will "deaden the higher brain centers," etc., when they have no tangible evidence that half their children have brain centers at all, but can readily believe that their brains are all in a whirl. The shops have practically given up teaching their apprentices at all, with about the same number of exceptions.

Drill Is Necessary

What is needed today is just what Mr. Whitcher condemns, education in detail drilled into the pupils, and the shops need teaching of detail work, not just simply repetition without thought, but intelligent repetition under intelligent instruction. There is not much real drudgery in learning the machinist's trade if the apprentice is taught the reason why for each step. Take our boy with a hundred studs before him. If he is simply given a sample and allowed to blunder along, making them in any way he sees fit, his "higher brain centers" may suffer. But if every step is planned out and the reason why drilled into him, then each part of the work becomes a thing of interest and he will learn in a brief space of time to make them carefully and accurately and rapidly, as compared with the too often practiced way of letting the boy pick it up any way that he can.

It is true that the average boy, say, of 16 years, is careless, very careless, about anything that he is not interested in. If he is interested in some vocation, to use the schoolmaster's term for a trade, he will be just as careful as a grown man, and a great deal more susceptible to instruction. If he is interested, as he will be if he is intelligently instructed and has any natural aptitude, he will stand a lot of drilling in any direction without stunting his mental growth.

Ordinary sheet brass or that in the form of wire, as free as possible from lead, is better than brazing solder (half copper and half spelter) for brazing iron or steel, according to the *Brass World*, as it is tougher and the joint is less apt to break. Its melting point is only slightly higher than the half-and-half solder, and not enough to interfere with the brazing operation in any way. Ordinary high brass wire is often sold as "spelter-wire" for brazing iron or steel.

Three Years of the Coöperative Courses

These Engineering Courses at the University of Cincinnati Have Operated during Industrial Depression to the Satisfaction of All Concerned

BY HERMAN SCHNEIDER*

In writing a paper attempting to give the results of three years of work in the coöperative system of engineering education, the problem is not so much what to say as what to omit. I have been asked so many questions concerning it that I realize that a paper of this length must leave a great many details unexplained.

The merit of the scheme is now generally admitted. But the skeptical still ask, "Does it work?" The answer to this is that it has worked, is working, and promises to work more smoothly from year to year. This is the one basic fact in the whole matter. In this connection it should be noted that though the course was started at the high tide of widespread prosperity, it has operated smoothly during the lowest ebb following a severe panic. When the work was first proposed the strongest objection raised to it was the possibility of a complete suspension during a business depression, many critics predicting that when a panic came the manufacturers would send all the students back to the university and that would be the end of the course. This year, when the effects of the panic are still felt, we have had requests from manufacturers for 100 additional students. The facilities of our institution, however, permit us to take only 70 new ones at this time. Therefore, we think we are safe in stating that *the plan does work*, and will continue to work in Cincinnati under all conditions of business.

Only the Best of Students are Entered

A feature that I emphasized when the course was first put into operation was the unique system of selecting students. I contended for many years that colleges were in great error in not selecting their raw material more carefully and rationally. In the average four-year course, any man is admitted who can pass certain examinations of a literary and mathematical nature. No cognizance whatever is taken of any qualifications for the engineering profession he may or may not possess. This point has been covered so often in former papers that only the figures for the last four years will be given to show the thorough character of our method of selection. The first year the course was in operation about 60 young men came to the university and inquired concerning it. Of these, 45 were taken into the shops for their preliminary summer work, and when the university opened in the fall 28 were entered. The second year there were 800 inquiries and applications. From these 60 were selected and sent into the shops in July, and when the college opened in September, 44 were recommended to us and started on their university work. The third year the inquiries and applications approximated 2000, but owing to the crowded condition of the university in its various departments, only 44 were selected and sent into the shops for their summer work, of whom 40 began their college work in September. This year (1909) the inquiries and applications have approximated 3000. From these we have selected 70 young men who are already at work in the shops doing their probationary summer work. It must be evident, therefore, that by reason of the selections made, the efficiency of the university is greatly increased. The dead wood is eliminated from our classes as soon as it appears, and no laggard is carried indefinitely to the detriment of the work of high-grade students.

The one thing that stands out prominently in these applications is the large number of young men who desire to become electrical engineers, but who do not know why they seek this profession. It is safe to say that not one man out of 25 applying for a place in electrical engineering has any idea of what electrical engineering means, and yet this is the kind of raw material which we are expected to make into electrical engineers. As far as possible, every young man who has entered our course has obtained before doing so a fairly good understanding of what this profession is. The young man selected for the coöperative course has a strong physique, has shown aptitude for his particular profession, and, on an average, his scholastic grades in accredited high schools are 90. It should be evident that the efficiency of our instruction is increased many per cent. by this careful selection of the raw material.

The Practice Shops are Gone

To the saving resulting from the elimination of the weak brother should be added that obtained by the elimination of the so-called "practice shops" from the university. The University of Cincinnati has "scrapped" its practice shops, and instead, uses the highly organized, well-equipped commercial shops of the city. The funds of a university should be used for brains, and not for machines. In many colleges brains are starved in order that the machine equipment may be kept up, and certain colleges of engineering, through striving to become imitations of commercial shops, get inefficient faculties on small salaries. If one-third of the money saved under the coöperative system were put into salaries for the teaching force, engineers who ought to be teaching and who are not doing so because of the small compensation allowed, would be attracted to the universities, and the universities would be what they ought to be—centers of real learning and research.

In accordance with this economic principle, our college of engineering teaches its students only such things as they cannot learn in practice. It does not attempt to teach the things that can be learned better in a commercial shop, or in the engineer's later career. There has resulted, consequently, a departure from the pedagogic system common to engineering colleges. I consider this the most important development of the coöperative course. During the past year, faculty meetings have been held weekly for the sole purpose of threshing out pedagogic problems. Each teacher was required to furnish the faculty with a complete syllabus of his work. This revealed a remarkable situation. It was found that broad fundamental principles were being taught over and over, not as *basic* principles, but as special little rules for special little machines. The student failed to grasp the big fact once and for all that these principles were broad and underlying laws, and not ingeniously devised formulas for special cases.

Courses Have Been Remodeled to Meet Real Needs and Avoid Overlapping

A number of courses, for example that in hydraulic machinery, were found to be but compilations of what the student had already had in other subjects, with much descriptive matter taken from catalogs. It was found, also, that many of the so-called "technical" courses which are merely descriptions of practical work, were entirely out of place in the coöperative system, where the student learns the same things more accurately in the shop. It was further found that in common with all other institutions, we were spending many afternoons on drawing courses, the value of which was questionable. This brought out a very beneficial discussion, and here again a peculiar situation was disclosed. In the case of every subject taught, the question, "Why do we teach it?" was required to be answered by the instructor teaching it.

The men in charge of drawing, replying

*Dean of the College of Engineering, University of Cincinnati.

to this question, stated that many of our students would become designers and hence they would have to know how to draw. They confessed, however, that the student has a good facility with his instruments at the end of his freshmen year. It was also shown by very thorough investigation that the real designer in a progressive shop himself spends very little time at the drawing board. If he is an alert man he is in the shop watching the performance of machines; he consults frequently with the salesmen to hear the objections to his particular machine and to get suggestions for its improvement; he does extensive experimental work, following in the steps of recent developments at home and abroad; and when he does any designing he sits at a roll-top desk, makes his computations and free-hand sketches, and turns these over to follow-up men, who can be obtained for about $75 a month. In other words, the drafting room is becoming to the designer what the typewriting room is to the management.

For these reasons, we hold that it is much more important for the future designer to spend the afternoons of his college days, after he has learned the necessary elements of drawings, in the laboratory and the library, and in consultation with his professor on research problems, leading to computations and free-hand sketches which can readily be interpreted by an inexpensive follow-up man, than it is for him to spend all this time laboring to become an expert draftsman. Without going further into this matter, suffice it to say that except where drawing instruments are absolutely necessary for certain classes of work, as in kinematics, the long periods of drawing have been eliminated from our course. Instead, the student is given definite problems based upon the fundamental principles of physics and is required to devote many hours to the laboratory and to the library in order to work out his results for presentation in the form in which they would go to the drafting room. In other words, our student is taught first that very essential requisite of the engineer: How to tackle a problem in the laboratory and in the library.

The Revised Teaching System

For these reasons, we have revised the teaching system as follows:

The first three years of the six-year course are devoted to mathematics and the fundamental sciences, together with the cultural subjects mentioned later. Physics is the backbone of the whole course, for there is not one principle used in engineering which is not to be found in physics. The teaching of physics has been modified to accord with the new system. When a student studies the principles of heat, for instance, he is told how they will be applied in his work in thermodynamics. The professor of thermodynamics starts then where the professor of physics has left off, and these principles will not be taught the student again as though he had never had them before; on the basis of his work in physics he will at once start on his problems in thermodynamics. After the first three years we cease lecturing to our students and demand of them original work based upon fundamental principles, which work, of course, is guided by the professor, but more after the method of the post-graduate seminar.

Besides the natural sciences there is another science just as important for the engineer, namely, the science of management. This embraces all the problems of shop economics, and these are introduced in the later years, after the student has had three years of experience in the various departments of the shop. Coupled with these sciences, there is a six-year course in the economic, social, political and industrial development of the human race and two years of general economics. There are also courses in the modern languages, sociology, sanitation, and English literature. About 25 per cent. of the university time, as distinguished from the shop time, is devoted to the so-called cultural subjects.

One of the striking things proved each year, is that the coöperative students are more vigorous, mentally and physically, at the end of the session than they are in September. This is to be accounted for partly by the alternation of work and study, and partly by the system of selection.

The advisability of a three and a half months' vacation in summer is, therefore, not evident. Consequently it has been decided to operate the engineering college eleven months of the year on the alternate work basis. That is to say, the college hereafter will open on the 1st of September and will close about the 1st of August. The work in the university during the hot summer months will be of such a character as not to require much night study. The vacation during August will be divided equally between each pair of coöperative students, one man working while the other is on his vacation, so that the shops will always be full manned. Objection may be made to this short vacation, but it must be remembered that this course is a man's size and that the average entrance age is between 20 and 21 years.

Shop Coördination

Another new feature is the method of shop coördination. The coöperative engineering course is of six years' duration. There will soon be, therefore, six classes, and there will be one shop coördinator for each class. The shop coördinator is a college graduate acquainted with shop practice. He spends every morning at the university and every afternoon in the shops. His function is to make a direct weekly coördination of the work of the shop with the theory of the university. One afternoon, for example, he may be at the shops of a local manufacturing company, where he will observe the student apprentices at their work. He will know what they are turning out, their speeds, feeds and cuts, the angle of the tool, how the batch of work is ticketed, how the work is set up, the power drive, everything important in connection with the operation. The next week, these young men will be grouped together with their classmates for two periods in class, when he will explain the functions of the particular articles, on which the students were working, in the machine which the local manufacturing company builds. He will take up all questions of speed, feeds, cuts, accuracy, etc. Figuratively speaking, he will take from the student apprentices the blinders which would restrict their vision except for this explanatory work. The ticketing of the batch of work is gone into, and the system of shop routing is explained. Ultimately all problems of shop organization, shop accounting, cost keeping, shop planning, power transmission, heating, ventilating, lighting, etc., are discussed during the six-years' course.

In conjunction with this, a card system is employed by means of which everything the student does in the shop that exemplifies a theory taught in the university, is called in detail to the attention of the teacher of the theory, so that when the student comes to that particular theory, the exemplifications which he has had in his practical work in the shop are called to his attention. It will be seen, then, that out of the student's own experience is drawn much of his course in mechanism, thermodynamics, machine design, strength of materials, shop economics, etc.

Trend of the Course

The question is frequently asked of us, what is the future development of this course? Prophesying is a rather dangerous business, but nevertheless developments have been such as to indicate a radical change in much of the future instruction in engineering colleges. It has been shown already in Cincinnati that the term "Engineering College" is too restrictive. What we shall probably be is a "College of Industrial Science." I spend every afternoon in the various industries of the city investigating the commercial production of the articles manufactured in Cincinnati. It has been shown, for instance, that there is just as much natural science and just as much business science needed for building a piano as for building a dynamo. There are just as many men employed in this manufacture in Cincinnati as in the electrical shops. But if a college of engineering were to place in its curriculum a course in piano building, a howl of derision would probably arise throughout the educational world.

There are many more industries which engineers consider minor industries, but which have a basis in science. If the investigator is fair, however, he will discover that a broad and thorough training is just as essential for their successful operation as for the building of a machine tool.

Since our colleges are endowed for the benefit of the public, and not to make life's pathway easier for the individual of average caliber whose father can afford to send him to school, it should be obvious that to meet the requirements of the industrial community the college of engineering must broaden into a college of industrial science. If we pursue this investigation a little further we will find that the first three years of work would be the same for the apprentices in the piano factory as for the apprentices in the machine-tool or electrical works. After they had received this broad training in the fundamental sciences, the mathematics, and the humanities, the students would enter upon their last three years with one backbone course of specialized study, together with the collateral branches applying to these particular fields of endeavor. The most promising young men from these factories would be selected to take this work. This new development has been brought forcibly to us by manufacturers in these so-called minor, and supposed non-engineering industries, who have proven to us the great dearth of well-trained men for their work. It is a function of the college of industrial science to prepare these men also. Here, then, is one probable development of the coöperative system.

The Field for Research Work

In the second place, there will grow up by the side of the college of industrial science an institute for industrial research, which will have about the same relation to the college that the research department of the Westinghouse company bears to its production department. It is a fact well known to educators that a good research man is often a poor teacher, and that a good teacher is frequently a poor research man. Yet we are always trying to make a good teacher do research work; often, too, a good research man is held down to a miserable salary because his teaching is not as efficient as it should be. Furthermore, in this country there is no central bureau of industrial research to which the superintendent of a shop may take his problem, and work side by side with a good research man in its solution. Germany has at least one such bureau under national direction, and also many under private or corporation control. The need for such an institution in Cincinnati is shown by the large number of demands made upon the university, since the cooperative course was started, for assistance in working out industrial problems of various kinds. If coöperative courses are inaugurated at other institutions, as promises to be the case, they will inevitably become colleges of industrial science, with institutes for industrial research attached.

Now, if a number of these universities have research institutes, it is obvious that they should be under one central management, so that a number of separate institutes would not at the same time be working on the same problem. Further, there should be a central office, with a large library, to which all problems should first be submitted. After submission, all the knowledge pertaining to a particular problem should be collated, and then the problem should be referred to the research man, or the laboratory best able to handle it. Under the system of central management it is evident that if the best man to do a piece of work were in Cincinnati and the best laboratory in Pittsburg, the man and the laboratory could be brought together to solve the problem. With the influence of a central bureau, a full-sized commercial plant could be obtained, if necessary, for an actual full-sized experiment. This would mean a national institute for industrial research at the minimum cost. The only expense would be the salaries for the research men, the laboratories being those of the colleges already in operation. It would not necessitate the building of great central laboratories, and it would result ultimately in the establishing of these bureaus at institutions in industrial centers, as, for example, at Boston, New York, Syracuse, Schenectady, Philadelphia, Pittsburg, Cleveland, Cincinnati, Chicago, Minneapolis, etc. In other words, there would be an institute for industrial research close to every manufacturing center, with the best brains of the country available, and with no expense for laboratories.

As planned at Cincinnati, the coöperative students in their latter years would assist research men in problems closely allied to their particular work, and we would obtain, therefore, in the production end of manufacture, men trained in the fundamental sciences, the methods of research, and the science of economic production. I believe that this national institute for industrial research, operated on these economic and elastic lines, would have as great an influence upon the industrial development of the United States as any plan the colleges could inaugurate. If a foundation of this kind were established it would bring to the colleges of industrial science, without cost, the best research brains obtainable, in exchange for which the colleges would furnish the laboratories. The limitations of this paper will not permit a further exposition of this probable development of the coöperative course. It is so apparent to us in Cincinnati, that we believe that it will be only a matter of a short time before this logical combination of the teaching college and the research institute will exist.

In developing these plans I have held firmly to the principle that the university should be an aggregation of brains and not machines; that it should furnish the best intellects obtainable in the country for the service of the country. I do not believe that the university should operate shops in imitation of commercial shops and thereby starve the brains of the institution. If a student is to devote 33 months of his life to study under skilled instructors, and 33 years to practical work, it should be obvious that he must be taught only those things in college which he can not learn outside.

The Developments in Brief

These, then, are the principal developments of three years of the coöperative system: The plan operates in times of industrial depression or prosperity to the satisfaction of the manufacturers, the students and the university; a logical combination of theory and practice, closely coördinated, has been worked out; a great waste of the funds provided for education has been eliminated by abolishing the imitation practice shops; the substitution of work in real shops at fair pay has made the college course possible to many more young men, and hence has permitted a selection of the raw material for making engineers; and the close contact with industrial life in an industrial center has widened the field of usefulness of the science college and has forecasted an institute for industrial research on elastic and economical lines.

An excess of phosphorus in bronze causes pin-holes in the casting. The ideal condition in the use of phosphorus is when just the right amount is added to the bronze to remove the oxide present in it, and a small quantity only is needed for this purpose. Owing to the fact that the quantity of oxide in copper or bronze is always variable (depending upon the manner of melting, etc.), the amount of phosphorus to be introduced can only be approximated. The same rule holds true of all deoxidizing agents.—*Brass World.*

The extent to which the industry of aërial navigation is becoming developed in France is hardly realized by any others than those living inside the radius of the aëro clubs and the national association of that country. Six months ago the builders of aëroplanes in Paris could be counted on the fingers of one hand. Now there are in full operation 15 factories devoted to the manufacture of materials and the construction of aëroplanes of all sizes, forms, and designs, besides a dozen or more inventors who are making under cover and more or less secretly individual machines which embody their special and more or less original ideas of what the aëroplane or dirigible air ship of the future ought to be.

Boring Milling Machine Columns —Oil Separator and a Novel Blueprint Frame

As is often the case, the small shop, from necessity and from conditions which do not exist in large factories, is very apt to do interesting things. The accompanying illustrations, kindly furnished by Mr. Oesterlein, of the Oesterlein Machine Company, Cincinnati, O., show instances of this kind.

Boring the Spindle and Arm Holes

Fig. 1 shows the way in which the holes for the spindle and the overhanging arm are bored in the milling machine made in this shop. After the face of the column has been scraped in, it is taken to this machine where the scraped face is clamped rigidly to the bed of the boring machine, as shown, the boring spindle being carefully alined at right angles to the bed. The holes are then bored and reamed, and on account of the vertical position of the boring bar, there is no trouble whatever from the reamer being clogged with chips. The boring bar is driven from the bottom through the bevel and spur gears shown under the machine, while the feed is secured by the rack and pinion on the quill, and can be fed by either hand or power as desired.

While the main holes are being bored, a fixture is placed over the bottom of the column, and a regular portable electric drill, rigged up as shown, is used to drill the bolt holes in the bottom flange.

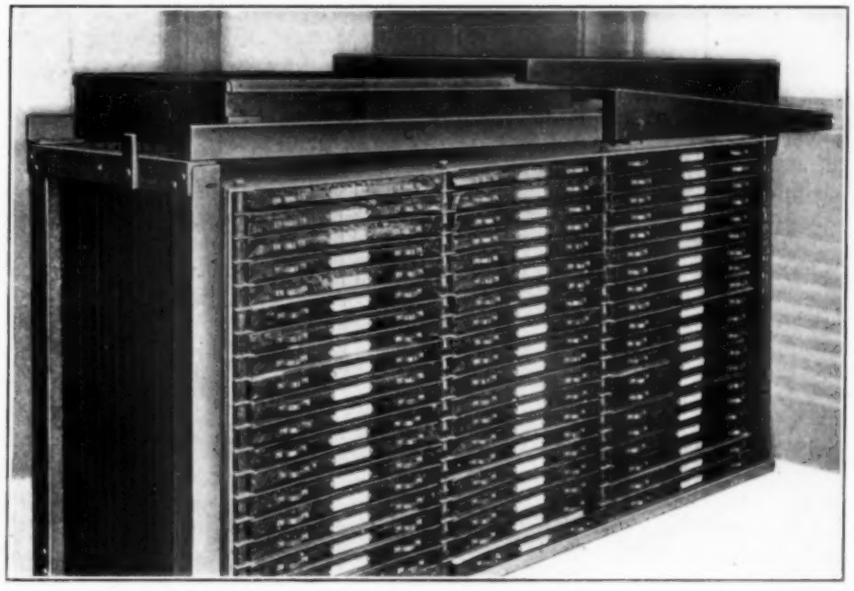


FIG. 3. A NOVEL BLUEPRINTING FRAME

A Novel Oil Separator

Near this machine is a very ingenious oil separator, which was designed by Mr. Oesterlein and is being used very successfully. It is a very simple affair, consisting of the wooden framework which supports an iron kettle, hinged in front on the cross-rod shown, and connected at the back with an elevating screw as indicated. The front edge of this is fitted with a guard and spout, so as to avoid spilling the oil as it is being poured off. This tank is filled with water, which is heated by steam from the small pipe shown at the back. The oily chips from the machine are shoveled into the wire basket, which is then lowered into the water, and the steam turned on. The hot water

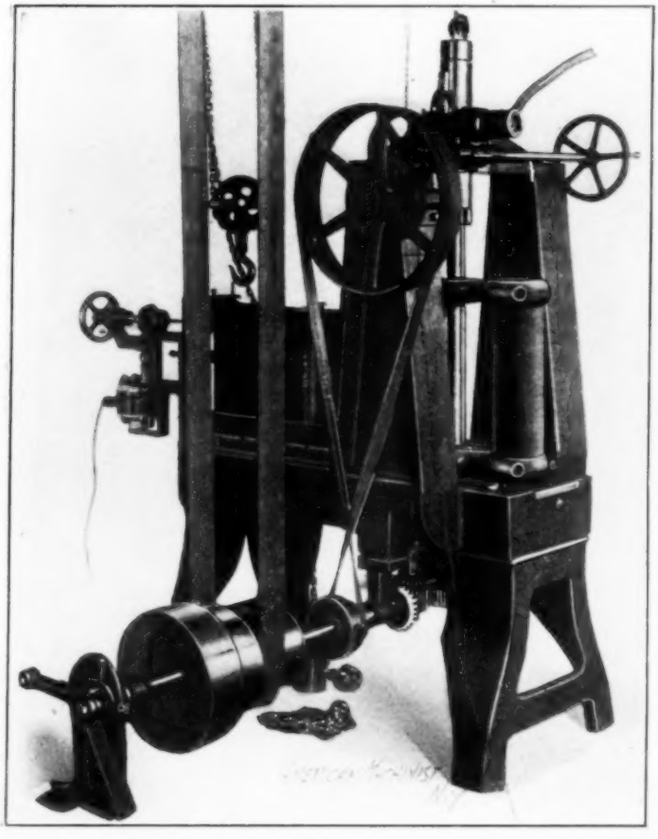


FIG. 1. BORING THE SPINDLE AND OVERHANGING ARM HOLES

FIG. 2. A SIMPLE OIL SEPARATOR

separates the oil from the chips, and being lighter than the water rises to the top, where it can be readily poured off by tipping the iron kettle by means of the elevating screw at the back. This is said to be very efficient and to remove practically all the oil from the chips in a very short space of time.

A Convenient Blueprinting Frame

The blueprinting frame used in this drawing room is about as simple as can be imagined, as it has no springs or clamps of any kind. The body *A* has a felt cushion on top and is mounted on wheels which run in the tracks formed by the angle iron *C*. On each track, just inside the window, is the wedge-shaped piece *D*, while *B* is the cover which contains the plate glass for holding the tracing in contact with the blueprint paper and allowing the light to act on it.

With the apparatus in the position shown, the blueprint paper is placed face up on the cushion, and the tracing laid over it. The body *A* is then rolled under the cover *B* until its front end comes in contact with the front board of *D*, carrying it along with the body *A*. The window being open, the whole thing is pushed out on the angle-iron track, which extends outside, and as the side of *B* leaves the incline *D*, the cover settles easily over the tracing and the blueprint paper, holding it in good contact by its weight and doing away with all springs and locking mechanism.

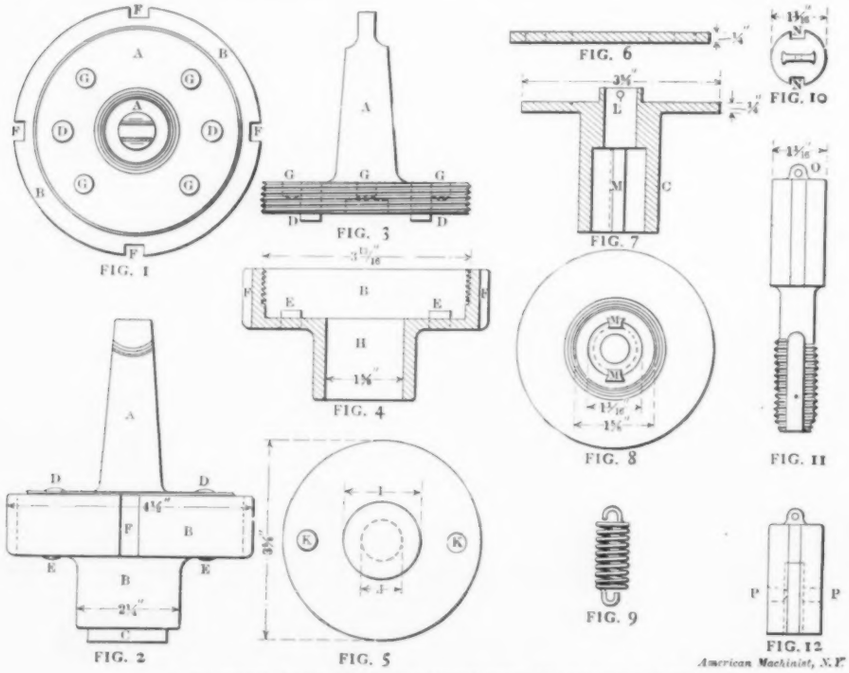
When sufficient time has been allowed for the print, the whole thing is pulled in, and as soon as the cover comes in contact with the incline on the side of the track, it is raised out of contact with the tracing, which is carried by the body *A* entirely clear of the cover, where it can be easily handled and taken to the washing tank in the usual way.

Space under the track is utilized for filing tracings, being built very largely of metal, the shelves being spaced by thimbles on the vertical rods which tie the whole thing together. Taken altogether, it makes a very convenient device, and one that can probably be used to advantage in many drawing rooms where the conditions are right for an equipment of this kind.

A Friction Drive Compensating Feed Machine Tapper

By J. Crosby

The tapper here shown and described is cheap to make, and has a face friction drive instead of one acting on the periphery, and there are no projecting lugs to cause any danger to the operator.



A FRICTION DRIVE COMPENSATING-FEED MACHINE TAPPER

Fig. 2 shows the tapper complete in elevation. Fig. 1 shows the plan, and Figs. 3 to 9 the details of its construction. It will tap up to 1¼ inches in gray iron, and give no trouble. Referring to the illustrations: *A* is a steel shank, turned to suit the hole in the drill spindle; it has a large steel collar at the bottom, as shown in Fig. 3, and has a thread 12 per inch. *B* is also a forged steel driver, shown in section at Fig. 4. *C* is the steel tap holder, as shown in section at Fig. 7, and in plan at Fig. 8. *D D* are two ⅜-inch steel driving pins, driven tight through the threaded collar on *A*. *E E* are two similar pins driven through *B*. *F* are four slots milled across *B* for an adjusting spanner to fit in when setting the friction drive for tapping different size holes. The four ⅜-inch round holes *G* drilled in the top of *A* are for a pin spanner to enable the operator to hold the part *A* still, when tightening up *B*.

Figs. 5 and 6 show the plan and elevation, respectively, of compressed red fiber disk, 3⅝ inches diameter and ¼ inch thick. Two of these fiber washers are used; one drops inside the bored chamber in *B*, and has a hole bored through it 1⅝ inches diameter, as shown at *I* in Fig. 5. The two driving pins *E* fit into the two drilled holes *K*. The other washer fits on the bottom of *A*, the two driving pins *D* fitting in the two holes *K*. The hole in the center of the top fiber washer is only bored out 1 inch diameter, as shown at *J* in Fig. 5. Figs. 7 and 8 show the tap holder and driver *C*, having a flange on the top, as shown, which fits between the two fiber disks, and thus presents a surface to tighten the disks onto, sufficient friction being thus obtained to drive a 1¼-inch Whitworth tap. *L* is a ⅛-inch hole, drilled through the small projection on top, as shown, to hang the spring, Fig. 9, on, a pin passing through for this purpose. The bottom book on the spring hangs on the small lug *O* on top of the shank of the tap, shown in Figs. 10 and 11. The tap is driven by two keys *M* dovetailed into the shank of *C*, shown at Figs. 7 and 8. The function of the spring is to pull the tap up to the top of the barrel when starting to tap a hole and also when backing out, which gives a compensating movement to the tap, both when tapping and reversing, so that it is not necessary to feed the drill spindle down in exact unison with the tap.

For taps of ⅝ inch diameter and under, a shank, as shown at Fig. 12, will do; it is bored ½ inch diameter for the taps, and has two pointed grub screws passing through *P P*, which pass into a pointed hole in each side of the tap to drive it. This tapper, of course, can only be used on drills fitted with a reverse. It is very substantial, and has nothing to get out of order. The parts *A* and *B* are adjusted to suit the different size taps to be used, being tightened up until just sufficient friction is exerted on the flange of *C*, between the two fiber disks to drive the tap. As soon as the bottom of the hole is reached the tap stops still and the friction slips while the shank rotates, and thus no damage is done to work or taps. The spindle is then raised, and the machine reversed, which backs the tap out of the work.

Titanium is being used extensively in the steel-rail industry in the United States. Its effect on the steel is very similar to that of vanadium, increasing their ability to resist wear. It is introduced into the steel in the form of ferro-titanium, an alloy containing from 12 to 15 per cent. of metallic titanium, the balance being iron.

A Self-contained Backing-off Attachment

To Be Used for Formed Cutters; It Is New in Design, Simple in Construction and Adjustment, has a Wide Range of Usefulness

BY W. J. KAUP

For the shoemaker to stick to his last is proverbially true, and to let the manufacturer who is producing formed cutters for the market take care of that particular function is, perhaps, wise; but every shop of any pretension has at some time or other, felt the need of some attachment for backing-off special cutters for special work, and one that would lend itself readily to quick adjustment on the different machines.

The difficulty that this particular attachment aims to overcome is the non-flexibility of design of those at present being used, in that they are not adaptable to other than the specific work for which the need was created. The present design has a broader field of usefulness and adaptability than for formed cutters alone, and is available for different types of cams and formed work either side or peripheral.

It has the means of being readily adjusted to any size of lathe or mill by a simple change of bearing, although there is no distinct advantage in changing from one machine to another, because the attachment is so quickly put on and taken off that one lathe can be used solely for all work.

General Construction

It is practically self-contained, as all the parts are carried from one casting, called the gear bracket, as shown in Fig. 1, where the attachment has been disconnected and swung at right angles. It can be used on any lathe, preferably one that has a good heavy spindle, by taking off the faceplate, and using a sub-faceplate, screwed on to the end of the spindle, the same as the ordinary faceplate, this sub-faceplate being designed to carry the gear bracket on its bearing.

Fig. 2 gives a view of the attachment entirely removed, showing this sub-faceplate, or gear bracket bearing, with the bearing or step on the end that carries the change gear, which is keyed on to this bearing and gets its rotation from the lathe spindle. The gear bracket which carries the intermediate gear and the cam-driving gear and shaft, is a running fit on the gear-bracket bearing, and is clamped to the lathe carriage by means of the cam-shaft bearing, as shown in Fig. 2. This bearing is bolted by means of the two bolts shown on the carriage and is also doweled.

The cross-feed screw is removed and the slide rest is connected to the spring which is held by a rigid stop on the lathe carriage. This stop can be moved to increase or decrease the tension on the spring, and holds the slide rest against the cam. The change gears are designed with face lugs, which carry the dog and work. The immediate gear is carried in a slot on the gear bracket, which allows for change of position when the gears are changed for a different number of teeth in the cutter.

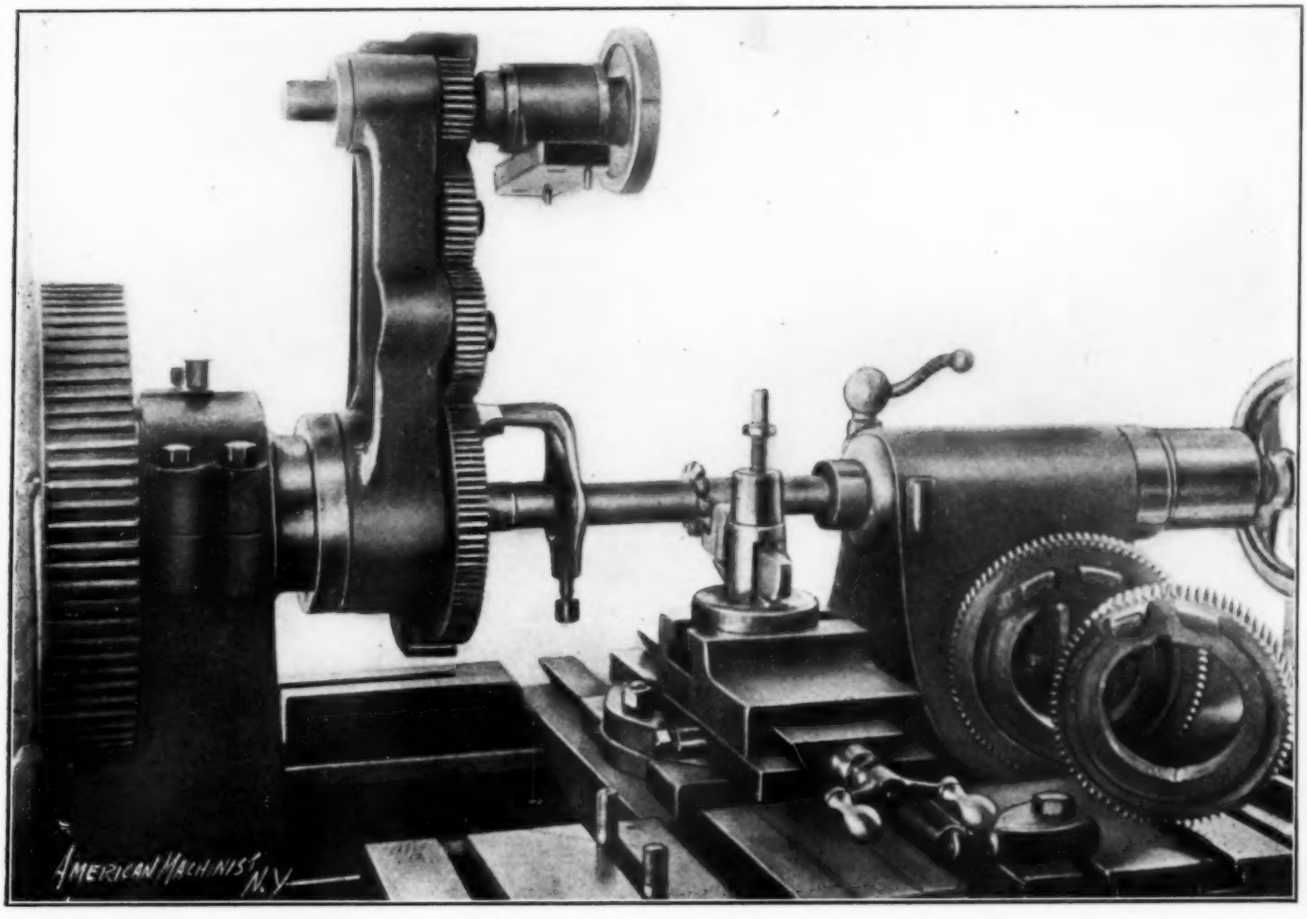


FIG. 1. SHOWING ATTACHMENT, SELF-CONTAINED, SWINGING OUT OF POSITION

A general view of the attachment ready for service, is shown in Fig. 3, with the gear guard attached to prevent accident to hand or clothes. The work is carried on centers on a mandrel and the tool is held in the tool post, as shown in Fig. 3.

The adjustment is quick, all that is necessary is to change the upper gear that carries the work, by unscrewing the lock nut and sliding off one and on the other. The intermediate is quickly meshed, due to the slot construction in the bracket and the machine is ready for a different number of teeth. The cam shaft runs in a specially constructed conical bearing in the cam-shaft bracket, with means of take-up, as shown in the line-drawing details, Fig. 4. A number of cams is possible for different throws or clearances, and are readily changed, and many irregular surfaces can be obtained by change of this particular feature. A hardened roller is carried on a stud which is screwed into the side of the slide rest as is shown in Fig. 1, and works against the cam.

The whole machine is designed with a view to lightness and durability, coupled with cheap production. The bearings are ample and well designed for oiling; all gears are protected. The different change gears are shown on the carriage in Fig. 1.

This page of details in Fig. 4 gives a general knowledge of its construction, the only change that would be necessary to make it available in any shop being in the gear-bracket bearing, which would have to conform to the threaded end of the lathe upon which it was desired to operate.

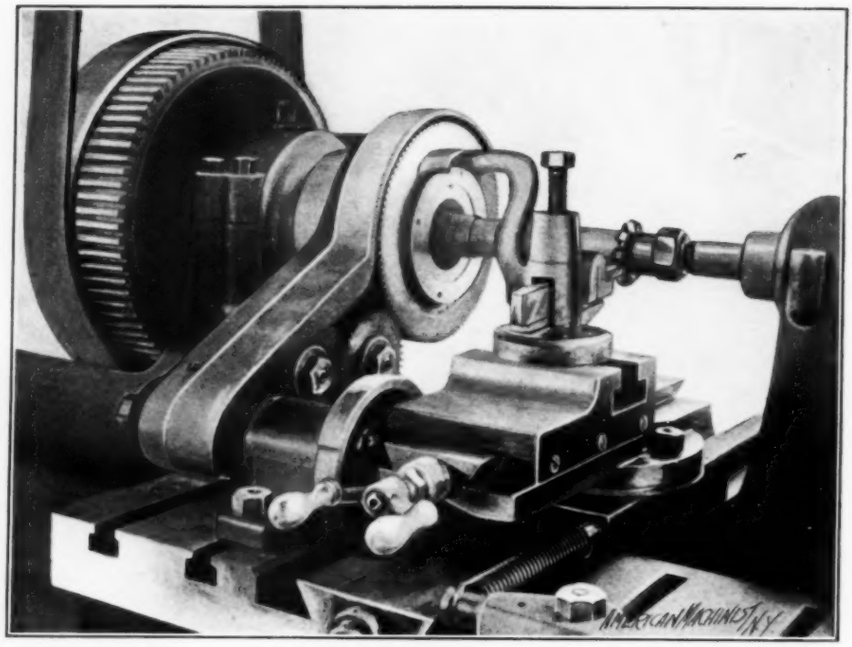


FIG. 3. GENERAL VIEW OF ATTACHMENT READY FOR SERVICE

Gearing

Any number of teeth in a cutter may be calculated in the same general way as gear cutting on a simple lathe. In this particular attachment three change gears only have thus far been used, as follows:

Change Gears.	Intermediates.	Cam Drive.	Number of Teeth in Cutter.
99	(2)		11
90	45	36	10
81			9

A 99 driver, 45 intermediate and 36 cam, with a four-lipped cam, will back off an 11-tooth cutter.

The range of the gear bracket allows for many more change gears and, of course, it is understood that the system of gearing must conform to the general ratio, in this case 9. It will be understood that other gearing ratios can be used as well as this. The device offers broader possibilities than formed cutters, however, and any shop will find it a convenient addition to its equipment.

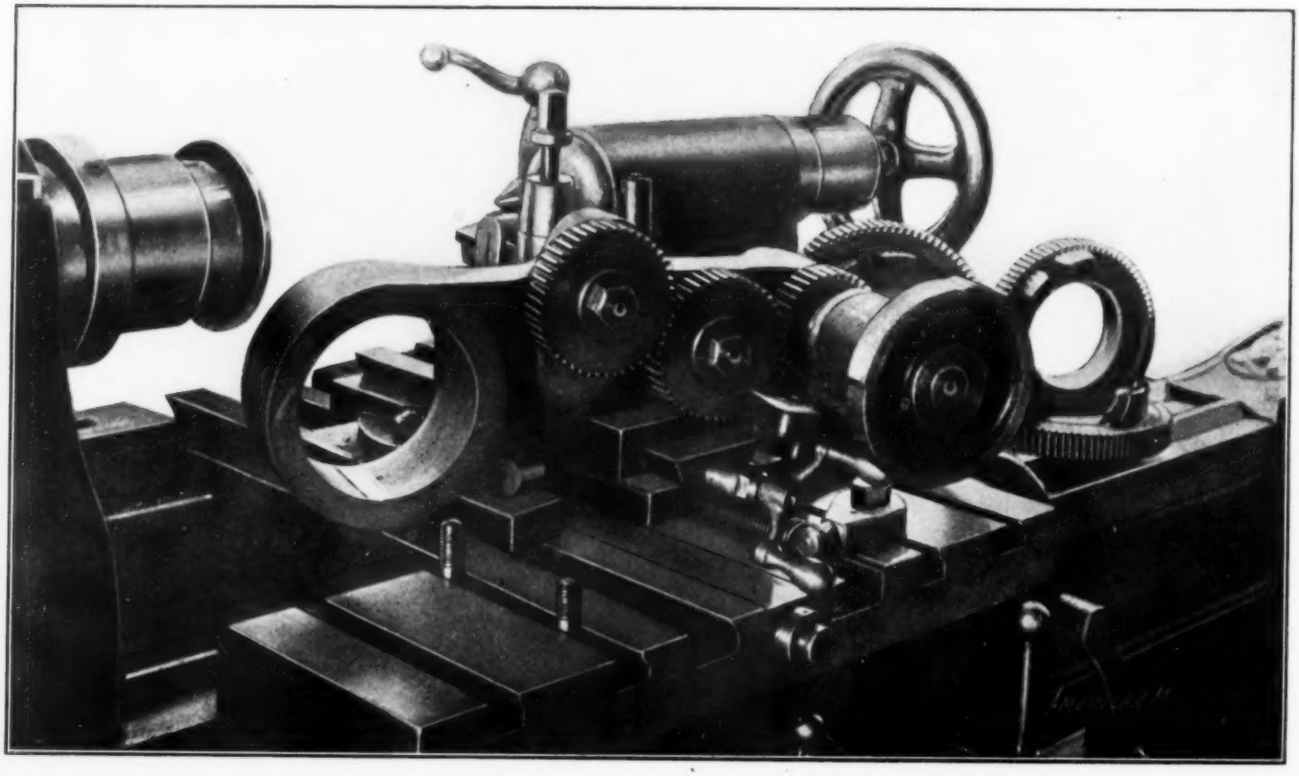


FIG. 2. SHOWING GEAR-BRACKET BEARING AND CONSTRUCTION

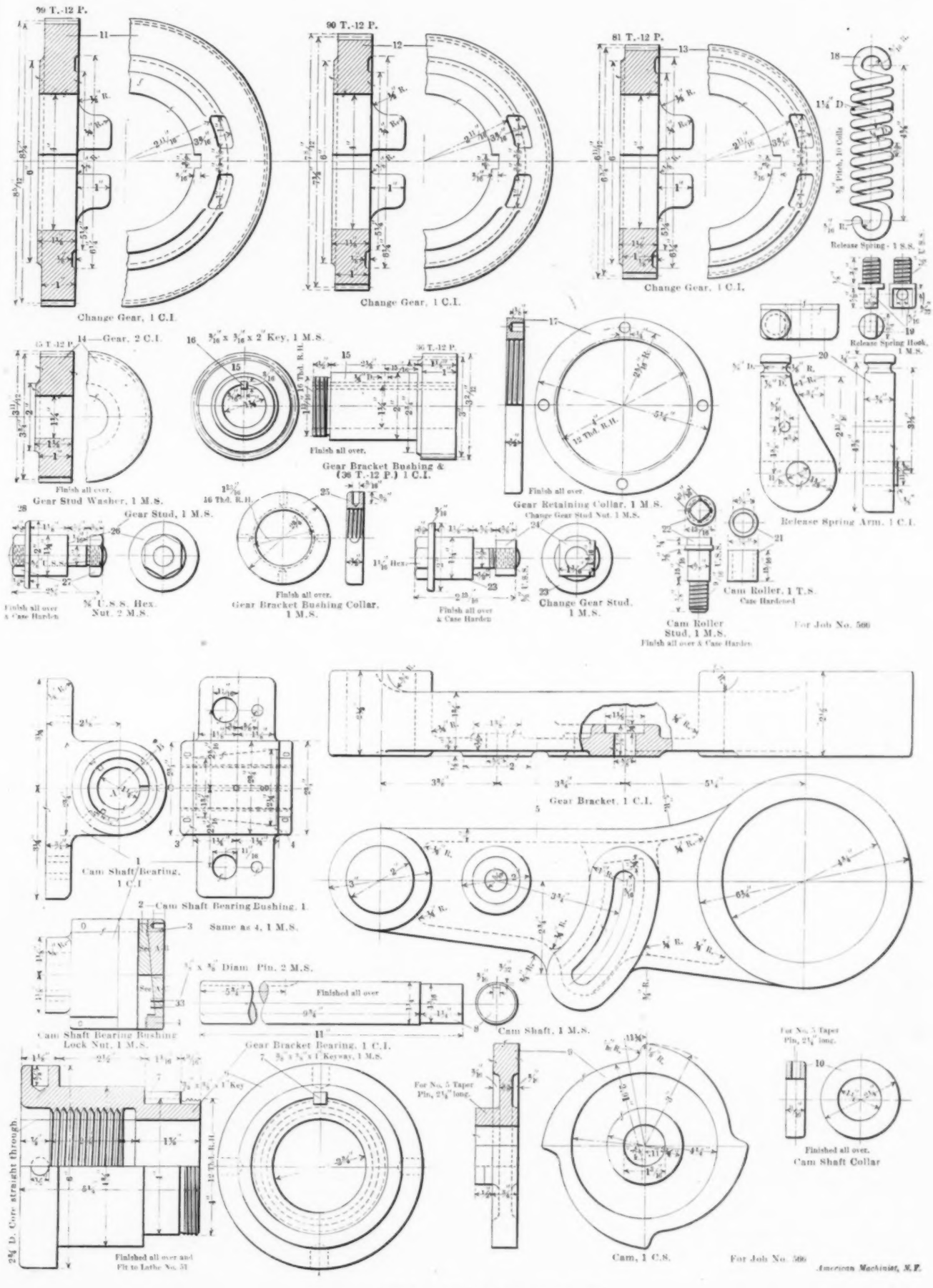

99 T.-12 P.
Change Gear, 1 C.I.
90 T.-12 P.
Change Gear, 1 C.I.
81 T.-12 P.
Change Gear, 1 C.I.
Release Spring - 1 S.S.
Release Spring Hook, 1 M.S.
Release Spring Arm, 1 C.I.
Gear, 2 C.I.
Gear Stud Washer, 1 M.S.
Finish all over.
Gear Stud, 1 M.S.
Finish all over & Case Harden
⅝ U.S.S. Hex. Nut, 2 M.S.
⅜" x ⅜" x 2" Key, 1 M.S.
Gear Bracket Bushing & (36 T.-12 P.) 1 C.I.
Finish all over.
Gear Bracket Bushing Collar, 1 M.S.
Finish all over.
Gear Retaining Collar, 1 M.S.
Change Gear Stud Nut, 1 M.S.
Finish all over & Case Harden
Change Gear Stud, 1 M.S.
Cam Roller, 1 T.S.
Case Hardened
Cam Roller Stud, 1 M.S.
Finish all over & Case Harden
For Job No. 599
Gear Bracket, 1 C.I.
Cam Shaft Bearing, 1 C.I.
Cam Shaft Bearing Bushing, 1
Same as 4, 1 M.S.
Cam Shaft Bearing Bushing Lock Nut, 1 M.S.
⅝" x ⅝" Diam. Pin, 2 M.S.
Finished all over
Cam Shaft, 1 M.S.
Gear Bracket Bearing, 1 C.I.
⅜" x ⅜" x 1" Keyway, 1 M.S.
⅜" x ⅜" x 1" Key
12 Thd. R.H.
2¾" D. Core straight through.
Finished all over and Fit to Lathe No. 31
For No. 5 Taper Pin, 2¼" long.
Cam, 1 C.S.
For Job No. 599
For No. 5 Taper Pin, 2¼" long.
Finished all over.
Cam Shaft Collar
American Machinist, N.Y.

FIG. 4. DETAILS OF BACKING-OFF ATTACMENT

Making "Under Reamers" for Oil Well Casing

By Carroll Ashley

Mechanics of the East may be surprised to know that we have here, in Los Angeles, a most modern machine shop, occupying several acres of floor space, equipped with the latest, "uptodate" tools for rapid production, and that we work the year around with doors and windows open.

The architectural design of the shop buildings is not beautiful, as they look more like large barns or warehouses. Each department is in a separate building, and the motive power is a 30-40-horse-power distillate engine. The buildings are mere shells, steel I-beam frame work, covered over top and sides with corrugated galvanized sheet iron. Near the eaves is a row of windows extending clear around, with generally two large skylights in the apex of the roof. Each building has several large doors for teams and cars to go in and out. Around the sides where no door intervene is a brick wall six feet high. The floors throughout, except in the forge department, are concrete. This plant is called the Union Tool Company, and has seven departments, viz: Mining machinery, gas engines, donkey engines, oil-well tools, foundry, forge shop, and shipping department.

Most of us who have worked in machine shops and tool rooms all our lives are strangers to the oil-well tool industry. In this part of the country it surpasses all other business in the manufacturing line.

When I first saw this work, it looked more like a milling job than a planer job, that is, the planer work did, but after working at it for over a year I am satisfied that the miller will never supersede the planer on this identical work. In fact, samples have already been submitted to the milling experts of the East, who, after computing the time of operation, and the inaccessability of some of the operations to cutters, have advised us to stick to the planers.

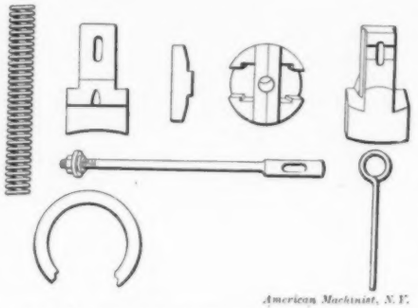


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FIG. 6. DOUBLE "UNDER REAMER" PARTS

I have seen quite a few reamers in my 20 years in the shop, but the "under-reamer" in oil-tool work is a new one to me, and perhaps will be to some of the readers of the American Machinist. The function of the "under-reamer" is to enlarge or ream a hole large enough, ahead of the "casing," as the casing is dropped into the drilled hole. There is no formation too hard for the under-reamer to cut.

Sometimes in a deep well the size of the casing gradually diminishes; where a casing is 13½ inches at the top, at the bottom it will be 3½ inches in diameter, consequently several sizes of reamers are used. The sizes we make run from 3½ to 13½ inches ordinarily, but larger sizes are constructed to order.

The reamers, together with numerous other tools, such as comb sockets, casing spears, casing cutters, casing blocks, casing hooks, hemp packers, perforators, rope sockets, rope knives, rig irons, etc., bring the cost of drilling a well, if it be very deep and in hard formation, to a high figure. The "fishing" tools (tools for recovering tools that have been lost in the well), all might, perhaps, be interesting, if properly described.

The steel used in the reamer body and the cutters is very hard and contains a percentage of nickel. The bodies are forged under the steam hammer and most of the cutters also, but lately a number of the sizes of cutters are drop-forged at the Bethlehem works and shipped by the carload to us.

Fig. 1 shows the under-reamer complete as it is in operation; it will be noticed that it is "collapsible," as when the operation of reaming is completed, the mere withdrawing of the tool pushes the cutters against the "shoe" on the bottom of the casing, the cutters collapse automatically and the reamer is drawn up through the casing. Fig. 2 is the under-reamer with cutters expanded, as in operation. Figs. 3, 4 and 5 show different views of the reamer. Now a study of the parts in Fig. 6, with reference to Fig. 1, will show the functions of the parts when assembled. The elongated hole in the cutters is for the key, this key being actuated vertically by the mandrel, when assembled, all together being controlled by a coil spring which draws the cutters upward to their seats, thus forcing the cutting edges to their greatest diameter. The

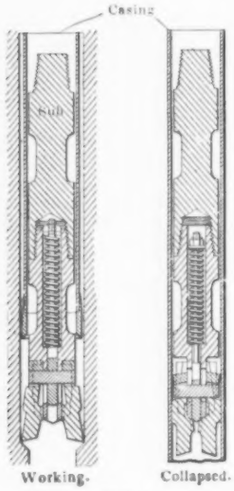


FIG. 1

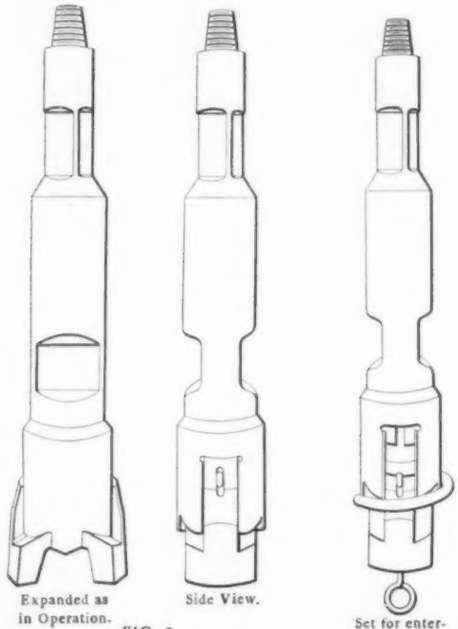
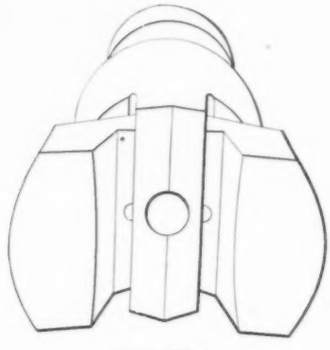


FIG. 2 FIG. 3



Bottom View.

FIG. 4

Cutters removed.

FIG. 5

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"UNDER REAMER" FOR OIL-WELL WORK

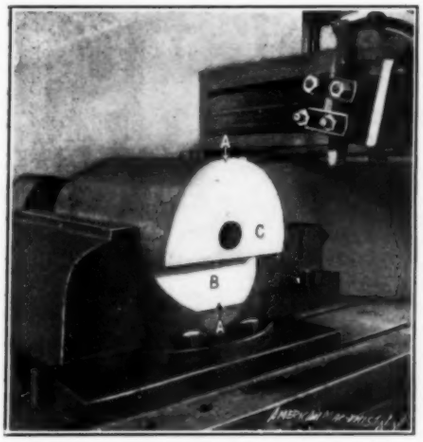


FIG. 7. CROSS-PLANING THE "UNDER REAMER"

FIG. 8. ROUGHING-OUT OPERATION

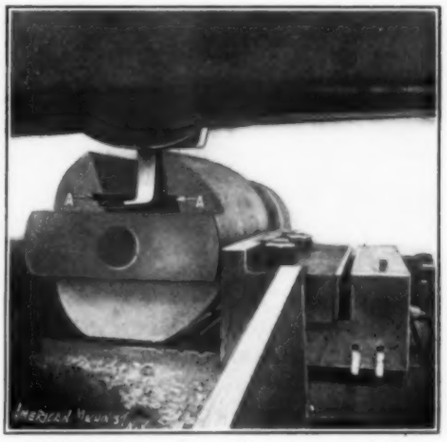


FIG. 9. DOVETAILING OPERATION

small groove in the center of the bottom of the cutters, seen in Fig. 6, is a clearance for the eyebolt, and is of use only in setting the cutters. This eyebolt is screwed into the end of the mandrel having the elongated hole; by pulling out on the eyebolt the cutters close together, thus allowing the setting ring (Fig. 6) to be slipped over the cutters. The reamer is then ready to slip into the casing. Fig. 3 shows the eyebolt and ring in position. The eyebolt is removed and as the reamer enters the casing the ring comes off. Space will not permit a description of the "joint turning," or drilling operations at this time, as the planing operations are most important.

FIG. 10. DOVETAILING THE "UNDER REAMER"

Fig. 7 shows the reamer body in the planer chuck for the cross-planing, which is completed in two settings. A flat surface *A A* is planed on two sides to a square shoulder, then the angle *B* is cut to 30 degrees. It will be understood that the under side of the reamer shown in Fig. 7 is finished and the top side has just been "flatted." The angle *C* is planed to 15 degrees. I want to state here that all this planing work is done at a cast-iron speed; the tools are of "Rex" and "Midvale" high-speed steel. All the measurements on this class of work are close enough, if within 1/64 inch, but at the high speed that the reamer bodies and cutters are planed, it is remarkable that such a degree of accuracy is maintained. The planer chuck is rarely removed from the platen of any of the six planers in the oil well tool department.

Fig. 8 shows the first part of the finishing operation on the under reamer. This is called "roughing out," but the large opening is planed to indicated measurements. On this particular size of reamer body, the complete time of planing (roughing out and dovetailing) was twenty-four hours; this time is now eight and one-half hours. The total amount of stock removed, on both sides, is 317 cubic inches.

At *A*, Fig. 8, is the clearance, which has

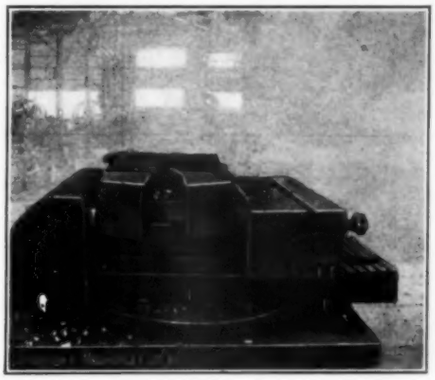


FIG. 11. FIRST OPERATION IN PLANING CUTTERS

FIG. 12. SECOND OPERATION IN PLANING CUTTERS

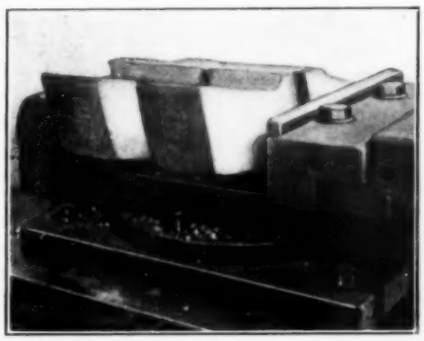


FIG. 13. THIRD OPERATION IN PLANING CUTTERS

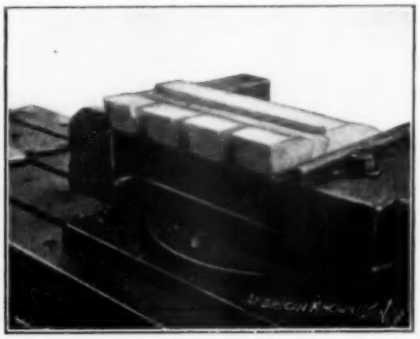


FIG. 14. FOURTH OPERATION IN PLANING CUTTERS

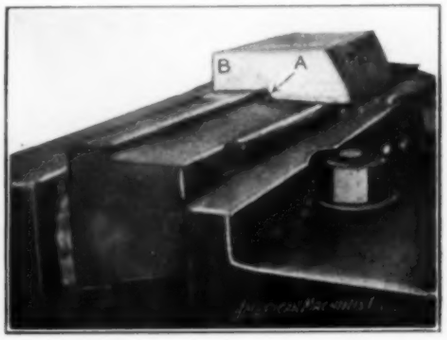


FIG. 15. EIGHTH OPERATION, PLANING DOVETAIL IN CUTTER

been drilled and chipped out to an angle of 15 degrees; this clearance cut is 1/64 inch deeper than the surface at one side of the tongue *B*. It will be seen that the forward stroke dog of the planer has to be changed quite frequently and the planer itself has to be a good one, one that will carry a cut up to 1/32 inch of the point of reversal.

Fig. 9 is a view looking under the planer rail from the rear, showing the dovetailing operation. Each dovetail is ¾ inch wide and tapers inward on the upper side from 2 inches at the 30-degree angle to 1⅜ inch at the clearance end. The opening is blocked out progressively with an under-cutting tool; that is, a tool 5/16 inch wide on the cutting face is fed in ¾ inch deep by hand, four times on each side *A A*, after which the reamer is partially loosened in the chuck and tilted, until a level placed on the taper gage shows level. Then another cut is taken on each side, *A A*, even with a line scribed off from the gage; this leaves a core that is then broken off and the rough edges are then smoothed up with the same tool. This core is seen in Fig. 10. Now at each stroke of the planer on this dovetailing operation, the tool must be relieved, or withdrawn slightly, and as each cut averages one hundred strokes and there are five cuts to each dovetail, and four dovetails to every reamer, the hand that does the feeding moves the handle two thousand times. The operator stands first on one side, then on the other side of the planer. Soap water is used as a lubricant on the dovetailing.

On what are called the improved cutters, there are eleven planing operations on the drop forged, and thirteen on the hammer forged, which means handling that many times in and out of the chuck; some of the cutters weigh nearly 200 pounds each.

There are other styles of older design that have an extra dovetail on each side, which calls for more operations. There are many interesting kinds of planer work on these cutters but it will make this article too long to enumerate them; however, I will give a general idea of the work.

Fig. 11 shows a pair chucked for the first operation, that is, finishing the sides. On the accuracy of this operation depends the accuracy of those that follow. The second operation is seen in Fig. 12. There are three surface cuts and one angle cut at *A*, to 15 degrees. In the third operation, Fig. 13, the cutters are tilted, and there are two or more surface cuts, according to the amount of stock to come off, which differs with the different sizes, and the ends are planed to 15 degrees; the completed operation is shown in Fig. 14. On some of the smaller cutters it is possible to hold four at one setting for this operation.

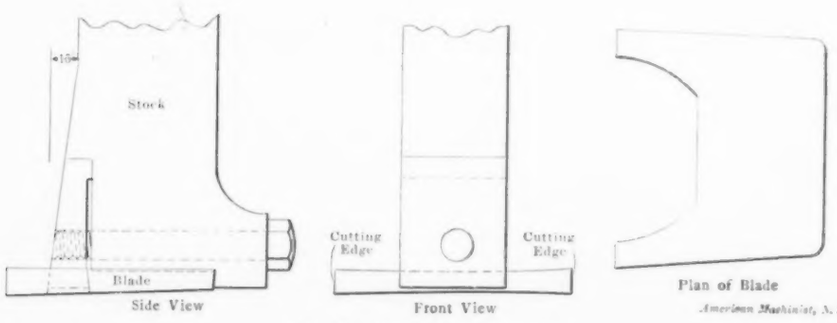


FIG. 10. UNDERCUTTING TOOL.

Now we will skip the operations up to the eighth, which is seen in Fig. 15. This shows a drop-forged cutter chucked for planing into the clearance, thus forming the dovetail. A slot has already been planed into a drilled hole at the point marked *A*. This slot is even with the shoulder *B*, and is at an angle of 30 degrees with the bottom of the cutter.

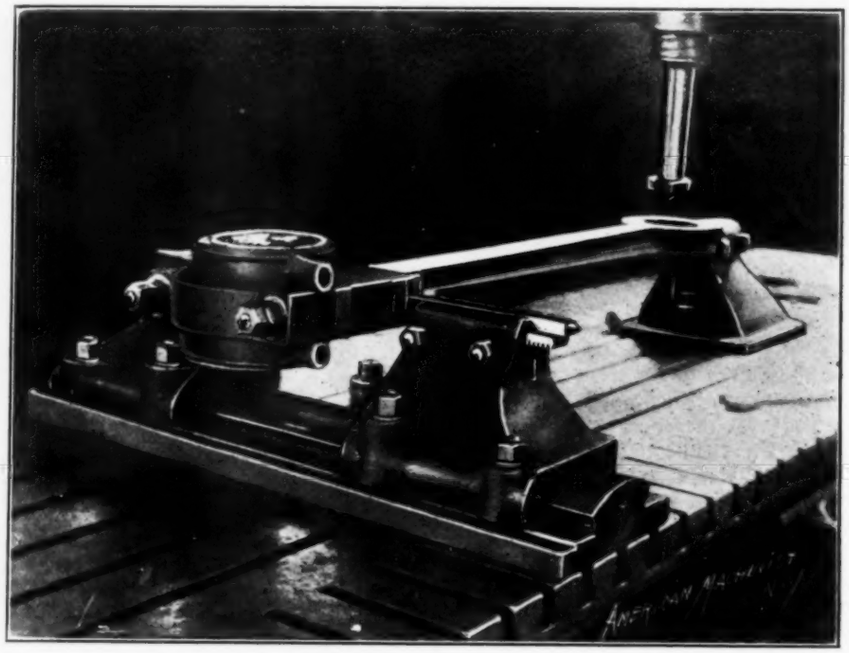
Fig. 16 shows my design of a tool for dovetailing. As will be seen the blade is removable, and the stock can be left in the tool block while the blade is sharpened. On account of the cut running in to an angular clearance, the cutting edges must be advanced. The blade is of high-speed steel and the stock and its parts of tool steel.

A Very Useful Method of Holding Work

The accompanying cut shows a three-centering rig or work holder which has been used by the Straight Line Engine Company, Syracuse, N. Y., for years with great satisfaction.

Holding things on a pair of centers is common enough, but it involves using other means, such as wedges or jacks, to hold the work level, and it also involves leveling up every time. With this arrangement after the three centers are drilled, the work is not only held secure without blocking, but can be turned over with the certainty that the two sides will be parallel.

This is not only used for the work shown, but for all kinds of odd-shaped pieces that cannot be held otherwise. The two heads on the cross-bar reverse, so that a wide piece can be held, and the same centers serve in a special device on the drill-press table to hold the connecting rod for drilling stud and bolt holes. This is really a shop tool rather than a special one.



PROFESSOR SWEET'S 3-CENTER WORK HOLDER

Henry Maudslay has always up to recent years had the credit of having invented the slide rest, while he worked for Bramah, the famous English lockmaker, before he started in business for himself in 1797. However, there is an illustration of a slide rest in a French mechanical encyclopedia printed about the year 1770.

Furnaces to Anneal, Harden and Color

Automatic Apparatus and Furnaces to Anneal and Harden Metals with Gas. A New Method of Coloring with the Gas Furnace

BY E. F. LAKE

As these are the days of automatic machinery, machines that will do work automatically or semi-automatically are found in nearly every line of industry. Until recently it has been considered impracticable to anneal and harden steel or other metals with automatic furnaces or apparatus, but now there are many different devices for doing the work in this way. Among the machines built for this purpose are those of the American Gas Furnace Company, Elizabeth, N. J., some of which are illustrated and described in this article.

The furnace shown in Fig. 1, the opposite side of which is shown in Fig. 2, is designed for automatically annealing large quantities of all kinds of struck-up or drawn work made in the nonferrous metals. It has a gas booster, by which the gas fed into the furnace can be regulated by adding or subtracting the round disk weights at the top. It will average at least 600 pounds per hour of ordinary brass or copper cups or shells. The output, however, depends more or less on the degrees of heat required to anneal the different materials, or the weight and size of the work.

The furnace body *A*, solidly lined with firebrick, incloses the cylindrical retort *C*, which extends from the feeding hopper *C* to the discharge end *D*. The work drops out from the door *E*, either into a quenching bath or other receptacle placed beneath it. This retort revolves upon the rolls *I I*, which are in both the front and rear, and it contains an inner spiral which ordinarily propels the work, with the retort in a horizontal position. By turning the handwheel *H*, however, the furnace can be readily tilted so as to slant the retort to any required angle, either up or down, and thus cause the work to feed out faster or slower as desired. The furnace body *A* is hinged on the trunnions *F* for the purpose of tilting it, and at *R* is located an indicator to gage the amount of the tilt.

The burner tips *P* enter the top of the heating chamber from opposite sides, and from the two burner channels *L L*, thus forming two burner sections, each of which is controlled by a gas valve *G* and air cock *M*, thus providing for varying the heat in the front or rear half of the heating chamber. At *N* is the air pipe and *O* the gas-supply pipe, the vertical section being flexible to permit tilting.

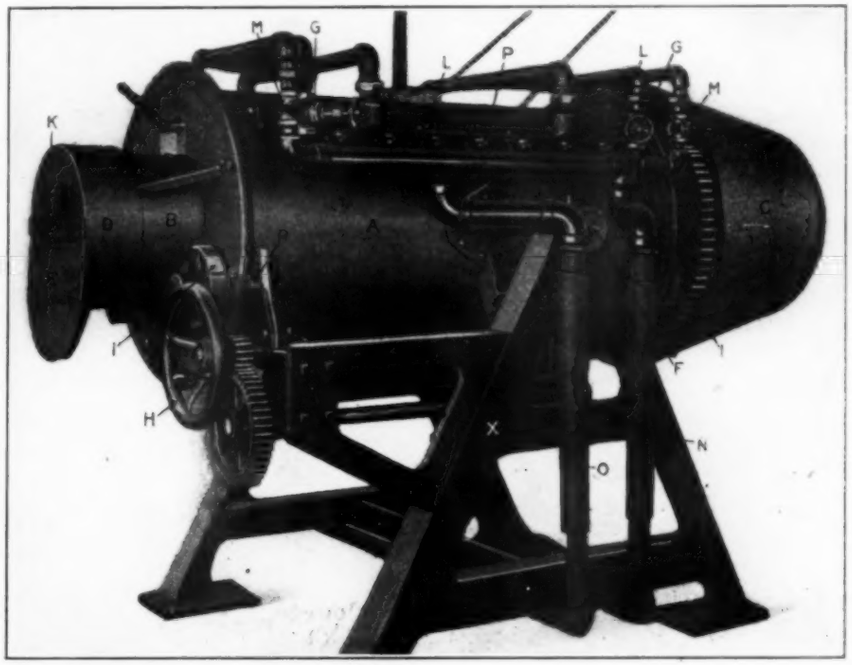


FIG. 2. OPPOSITE SIDE OF FURNACE SHOWN IN FIG. 1

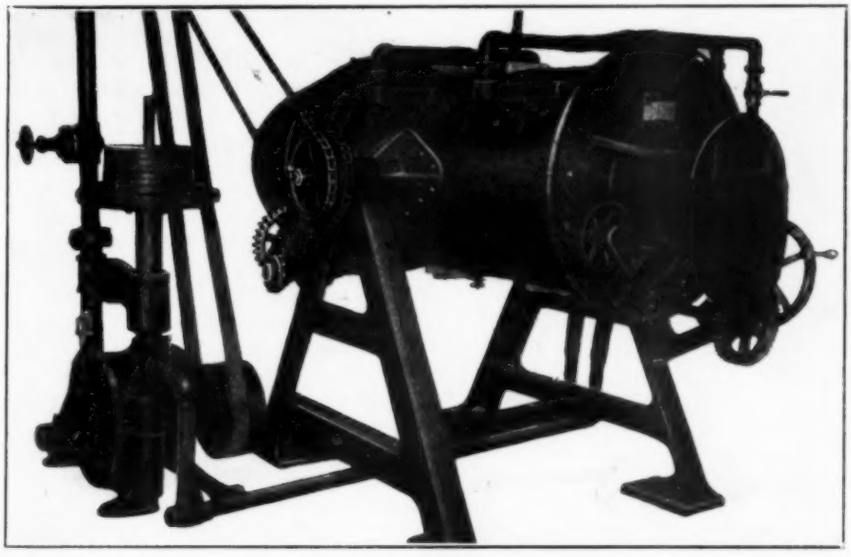


FIG. 1. FURNACE FOR AUTOMATICALLY ANNEALING NONFERROUS METALS

In operating the furnace the work is put into the hopper *C*, which contains a scoop of the proper capacity for the size and kind of work to be done. This scoop fills itself with each revolution of the retort and drops the work into spiral conveyers in measured quantities. This propels it through the retort to the discharge door *E*, and it can be inspected, before leaving the furnace, through the peep hole *K*. If the work is not annealed properly the furnace can then be tilted forward or backward to accelerate or retard the travel of the work by merely turning the handwheel *H*.

The consumption of gas is in proportion to the heat units it contains, and with illuminating gas containing 650 B.t.u., the consumption averages about 1 cubic foot per pound of metal.

Automatic Apparatus for Quenching Tanks

The continuous hardening of steel has been a proposition that has developed various kinds of apparatus for doing the work. In Fig. 3 is shown an automatic gas heating furnace that is discharging its work into a tank for quenching, that contains a conveyer for removing it from the tank into receptacles with which it can be carried away.

In Fig. 4 are shown two tanks, into the first one of which the work is dumped from the furnace for quenching and from there it is conveyed to the second tank, in which the work is cleaned and from there it is conveyed to pans, trays or other articles with which it can be easily handled around the shop.

These can be used for conveying metal articles through a bath of water, oil or chemicals and while it was primarily designed for quenching incandescent steel articles to give them hardness, it may be used for cleansing or chemically coloring other metal articles, ferrous or nonferrous, or for passing metals through a rust preventative bath and a variety of other purposes.

Hardening Articles in Bulk

When hardening small articles in bulk, the usual practice, in quenching, is to deposit the heated articles in a receptacle, usually called a basket, and then plunge the basket into a cooling liquid. The liquid which comes in contact with the articles in the middle of the mass has been highly heated by contact with the surrounding articles and the result is unsatisfactory, owing to the different pieces not being uniformly hardened. Many times individual pieces are also unevenly hardened due to one side being exposed to cold liquid while the liquid on the other side of the piece has become heated.

This apparatus overcomes these objections, as the work drops from the furnace into the quenching bath in a continuous stream and from the hopper, as shown in Fig. 4, the work is fed through a perforated barrel, that inclines down to the other end of the tank, where it is picked up by the conveyer and discharged from the tank.

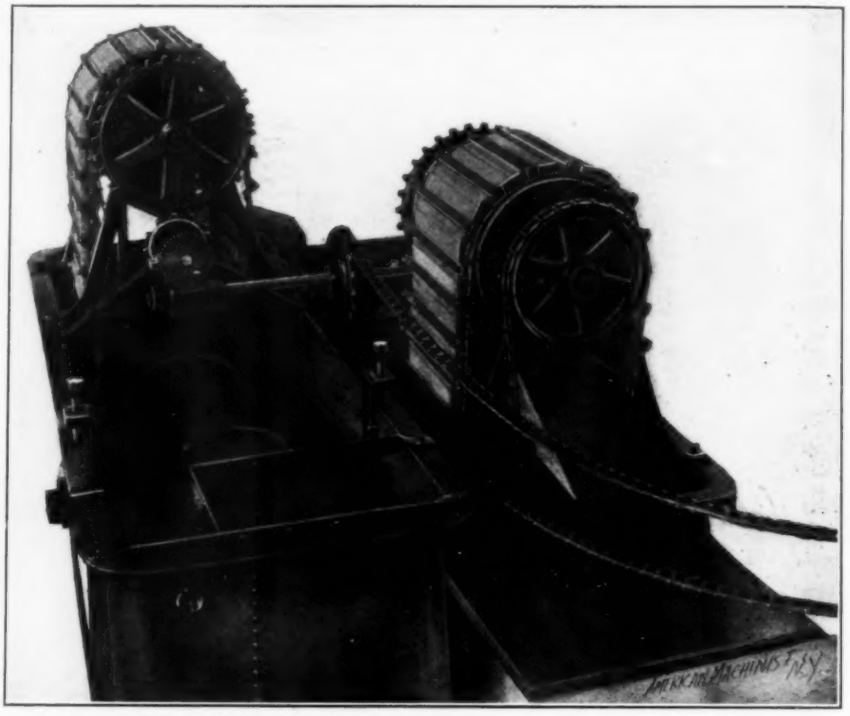


FIG. 4. TWO AUTOMATIC TANKS AS USED FOR QUENCHING AND CLEANING WORK

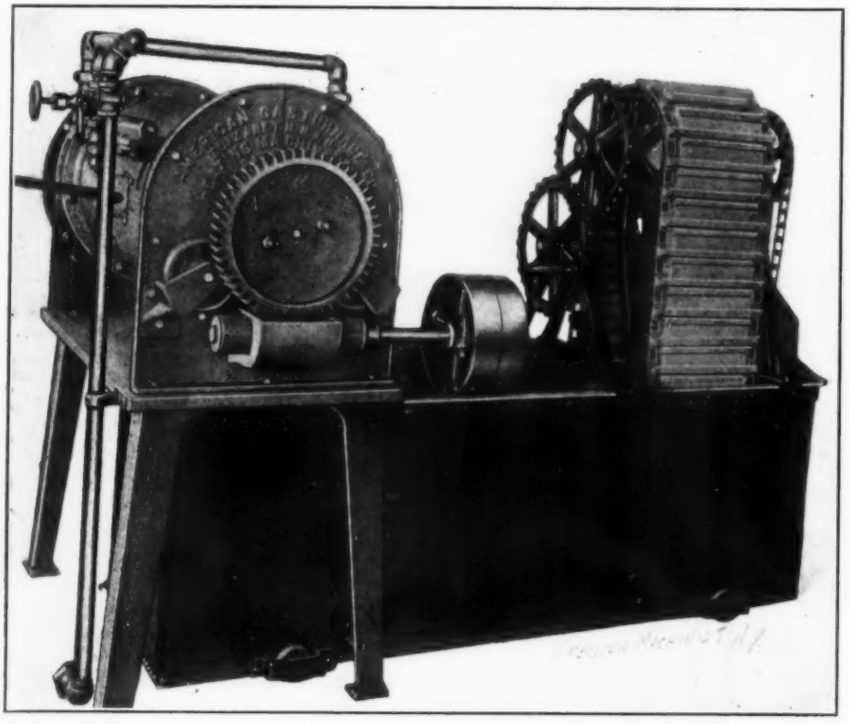


FIG. 3. HEATING FURNACE DISCHARGING INTO AUTOMATIC QUENCHING TANK

The perforated barrel revolves slowly to agitate the articles, thus bringing them in contact with the quenching liquid on all sides. The liquid is admitted to the tank beneath the receiving end of the barrel and as it becomes heated, by contact with the articles, it rises and is drained off, from the top of the tank, near the discharge end of the barrel.

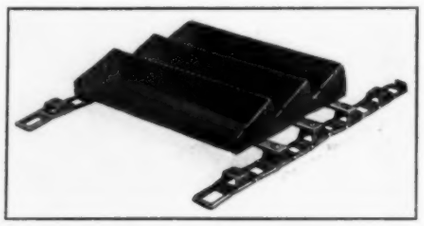


FIG. 5. A SECTION OF THE CONVEYERS

At the lower end of the barrel the pieces are picked up by the lower loops of an endless chain that is formed of buckets open on the inner side. They are elevated by this and dumped into a fixed hopper within the upper loop of the chain and from there the discharge chute leads them away from the tank. The buckets, a section of which on their chains is shown in Fig. 5, are perforated so as to strain the liquid from the pieces hardened.

Double Tanks for Hardening and Cleaning

When desired, two tanks may be coupled together and the work that is quenched in one may be sent through a cleaning compound in the other and thereby made ready for use. For instance, work that is quenched in oil may be sent through a second tank containing some liquid that will cut the oil from the work and leave it clean, or a liquid that contains chemicals, that act as a rust preventative, may be used in the second tank. In fact there are several combinations for which the double tank is useful, and it therefore may be applied to different kinds of work.

The hopper end of the barrel is movable so that it may be raised or lowered to cause the work to travel fast or slow through the quenching bath as may be desired. When the work needs to be conveyed to an upper floor, or a distance away from the bath, it may be done by extending the elevator to the place desired. If the work needs to be carried to the floor below, the discharge chute may be extended for that purpose. The tanks are also fitted with rollers so that they may be rolled under the furnace, or to any part of the shop.

A floor plan of the heating furnace and the automatic quenching tanks is shown in Fig. 6.

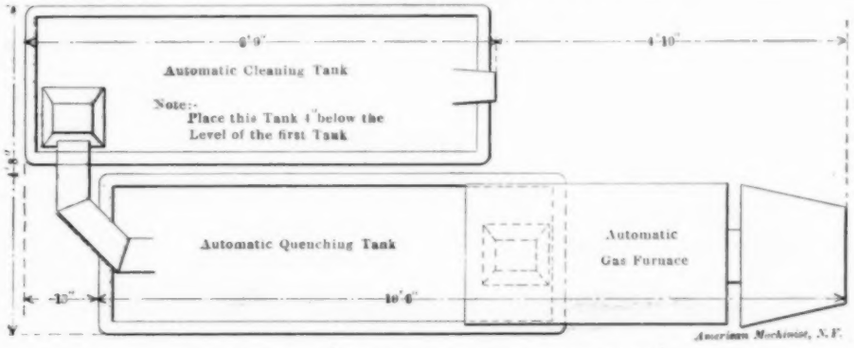


FIG. 6. PLAN FOR LOCATING FURNACE AND TANKS

Coloring Metal in Furnaces

Another style of machine, that is used principally for coloring metals, is shown in Fig. 7. This furnace is semi-automatic and in operating it a charge of sand and work is put into the retort; the furnace is then heated up and the work is revolved in this retort which rides on the wheels shown on each end of the shaft on the side of the furnace. A similar shaft is located on the opposite side of the furnace and both are driven by the gear, shown in the center, and a worm.

The retort, as shown in Fig. 8, is made of a perforated tube on the outside of which is a spiral for carrying the sand, that is brought forward by the work, to the back end of the furnace. On the inside of this retort is another spiral that moves the work forward. Thus the work, with the sand, is brought forward inside the perforated shell, while the sand, which separates from the work by going through the perforations, is taken back and the work comes out clean. The work is given its proper color by keeping the furnace and sand at the proper temperature and adding the correct chemicals.

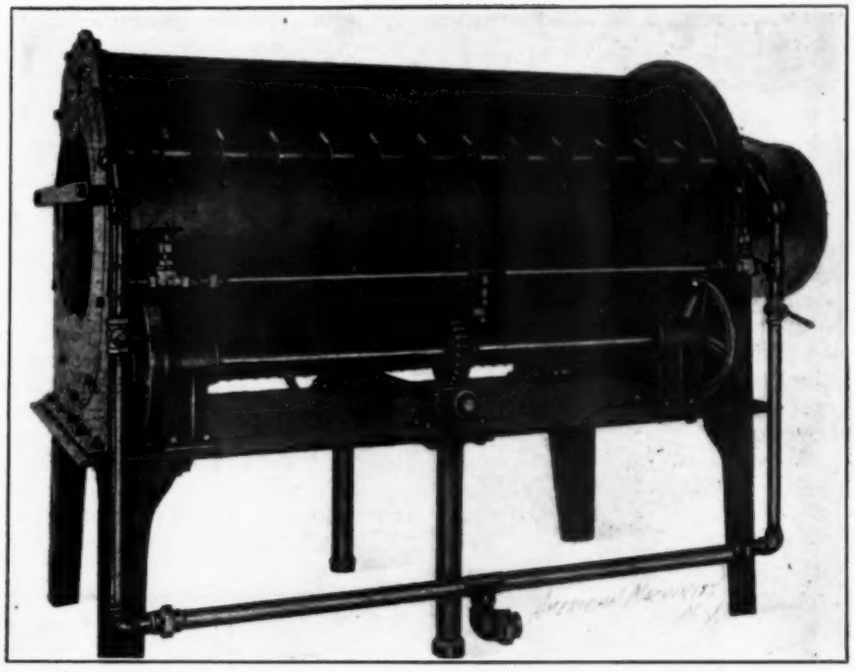


FIG. 7. GAS FURNACE FOR COLORING METALS WITH SAND

Gun Metal Finish

The black color, sometimes called gun metal finish, that is given the steel in small arms as well as numerous other kinds of work, has led to the development of a gas-heated furnace for doing this work. This color is given the steel, not only for the purpose of making the different parts of a thing the same color and therefore have it pleasing to the eye, but it also acts as a rust preventative. Thus the pieces that are handled by perspiring hands do not show the effect of rust or if kept in a moderately dry place rust will not start forming.

The work has to be heated to a temperature of about 600 degrees Fahrenheit and, therefore, any steel that this will destroy the required temper of cannot be colored in this way. For all pieces that will stand a drawing temperature of 600 degrees Fahrenheit the color will be a uniform black, that will be dull on rough work and partially shiny on polished work.

The color is not in the form of a coating on the outside of the steel but a very thin layer of the metal itself is turned to the proper color and this makes it wear

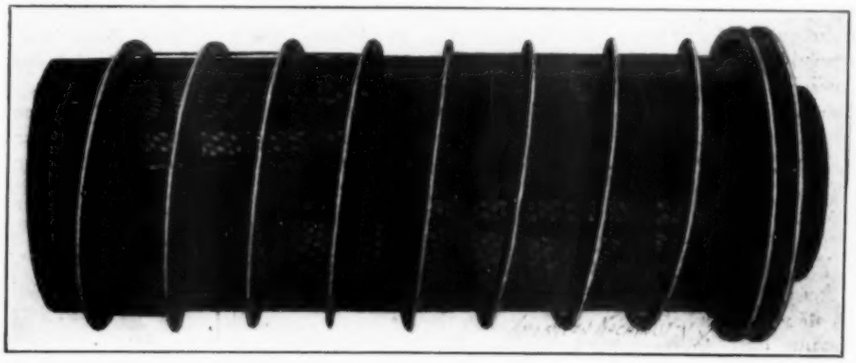


FIG. 8. RETORT WITH WORK AND SAND SPIRALS FOR FURNACE

well when compared with steel colored in other ways.

The Furnace

The special furnace for giving steel the "carbonia" color, which is the name that has been given this finish, is shown in Fig. 9. The outer shell *D* of the furnace is lined with fire brick and this is heated by the gas. The round retort, the opening of which is shown at *H*, is placed inside of the outer shell and this revolves on 4 wheels, two of which are at each end of the furnace, as shown at *E*.

In Fig. 10 is shown the opposite side

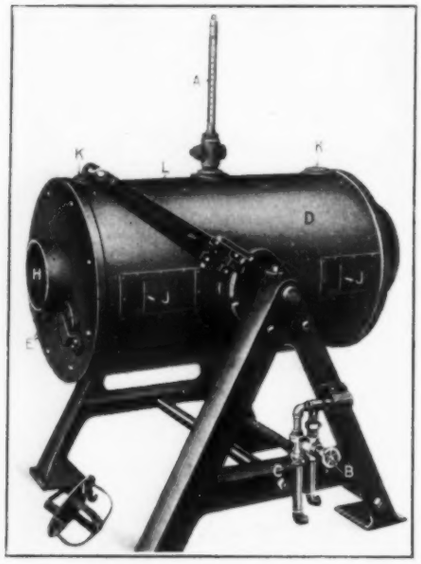


FIG. 9. FURNACE FOR PUTTING GUN METAL FINISH ON STEEL

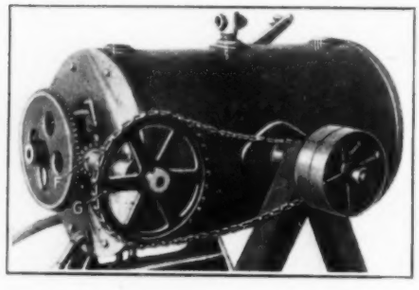


FIG. 10. OPPOSITE SIDE OF FURNACE SHOWN IN FIG. 9

and end of the furnace and this shows the bevel gears, sprockets and chain that is used to revolve the retorts by a belt from the line shaft. Vents are provided for the gas chamber at *K* and the burners are lighted through the slides *J J*.

In operating the furnace a mixture of charred bone and carbonia in equal parts, by volume, is put into the furnace through the open end *H*. The work is then put in; the cover *I* used to close the hole and the whole mass is revolved in the retort, until the work has been thoroughly colored. A thermometer is located at *A* so the temperature can be observed and this kept even throughout the coloring process. When the work is thoroughly colored, the furnace is tilted by the handle *L* so that the work will fall out.

Materials Used and Work Done

The charred bone must be well charred and for that reason the company is selling the bone to supply the furnace. The carbonia is a chemical in the form of a liquid that is made and sold by the company in order to keep the mixture at a given standard. It sells at 50 cents per gallon and hence is not an expensive proposition. The charred bone is not an item of much expense, as it can be used over and over again. The gas and air valves are regulated at *B* and *C* and when once properly set the furnace can be kept at a uniform temperature throughout the heat.

The quantity of work to a charge depends upon its weight, shape and dimensions and this is best determined by a trial run. Work that is light in weight and does not pack closely can be filled into the retort to a level with the bottom of the entrance at *H*. Work that is apt to stick together, bunch or clog or is too heavy to tumble easily should be treated in small quantities. Samples of the work may be taken out to observe the color when a new batch is being treated, but after the time and the degrees of heat are ascertained, batches can be temper colored without sampling because they all require the same heat and time for giving them a certain color.

Samples, which show the variety of work that is being colored by this process, are shown in Fig. 11. As will be seen they vary from gun barrels and parts of small arms, to pneumatic tool handles, clippers, spectacles, buckles, chains, bits, hinges, wire, etc.

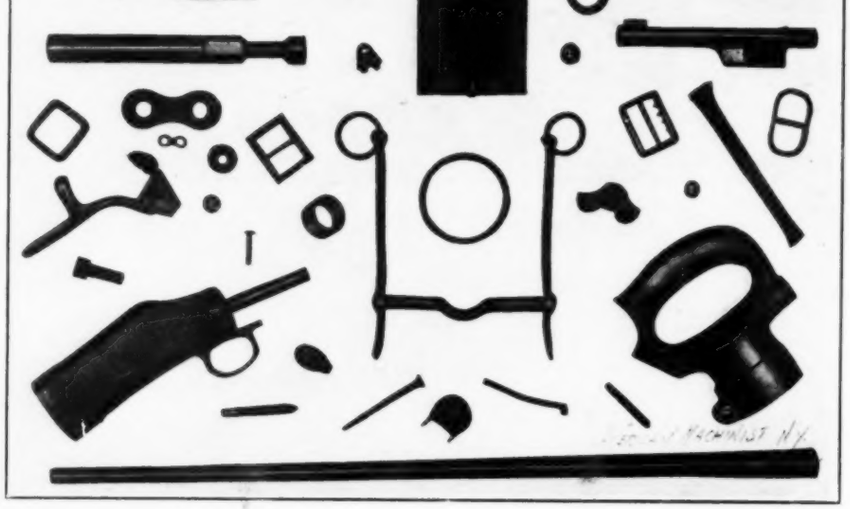


FIG. 11. SAMPLES OF WORK GIVEN THE GUN METAL FINISH

Rethreading a 1¾-inch U. S. Thread with a Pipe Cutter

By Old Timer

A trolley car was pulled in at our car barn with one motor disabled. Owing to a defective lock washer, the nut (1¾-inch, 5-thread) holding the pinion on the end of the taper shaft of the armature had worked its way loose, until held from dropping off only by the side of the *dust pan*, or gear casing.

A good many miles of travel under these conditions effectually burred the thread on the end of the armature shaft so as to unfit it for further use until the thread was recut.

Our largest dies were 1¼-inch. Repairs had to be begun at once, and as per ordinary railroad systems, quickly. Regretting the want of a lathe, I proposed using an ordinary pipe cutter, which we proceeded to use as follows:

The pipe cutter was of the three-wheel variety. I had it placed on the end of the shaft where the thread was good, two of the cutting wheels at the bottom, the top wheel, with the addition of a washer, being placed slightly out of line (or staggered) from the two lower wheels.

The pipe cutter was then with great care adjusted to the good thread and carefully worked ahead. This method effectually cut the thread to the end of the shaft as required. A spare 1¾-inch nut was then taken and four slots cut across the thread longitudinally with a half-round file, thus making an *ex tempore* die.

This, with care, elbow grease and lubricating oil, finished the job. The proper nut went on O. K., a little tight fit certainly, but this is just what we wanted. Time of operation, 40 minutes.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Tools for the Production of Staples

The drawings herewith show a set of tools which were designed for the production of staples, such as are shown in Fig. 1.

The blanking tools are shown in Fig. 2, and are interesting because of the fact that they produce a blank by means of what are really piercing punches. The stock, which is known as hoop iron, procurable in suitable widths, is fed through punches *F* and *G*, piercing the staple holes and screw holes respectively, and punch *H* separating the blanks, so that after the first blow a finished blank falls from the press. It will be seen also that the blanks and scrap fall in separate places, only the scrap going through the die, the blanks falling into a box at the side of the press.

When the screw holes have been countersunk in the drill press, the blanks are assembled in the handpress, by the tools shown in

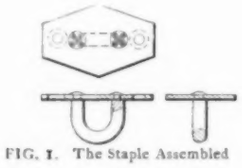


FIG. 1. The Staple Assembled

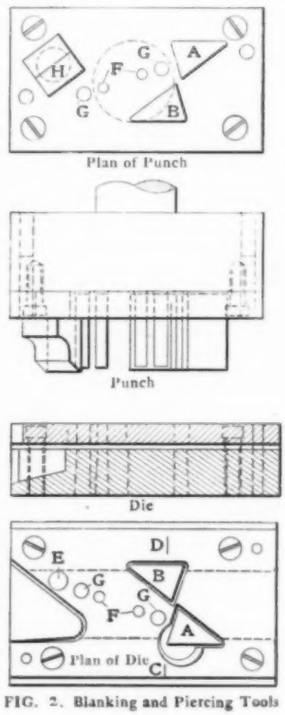


FIG. 2. Blanking and Piercing Tools

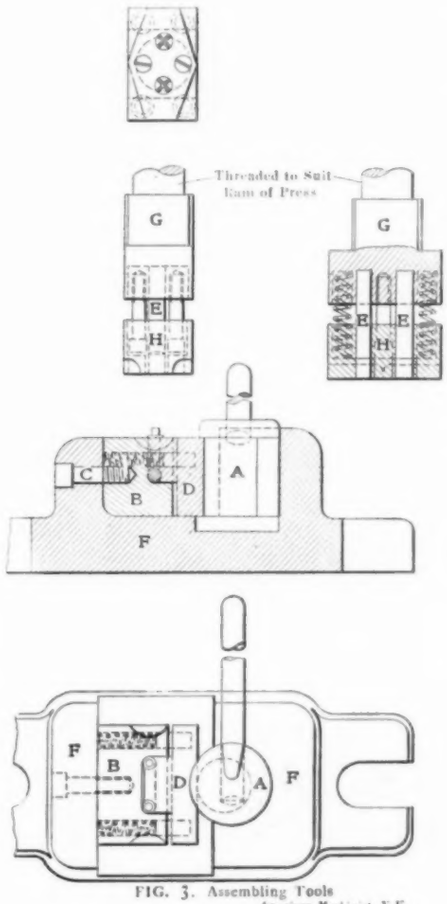


FIG. 3. Assembling Tools

American Machinist, N.Y.

TOOLS FOR THE PRODUCTION OF STAPLES

the gage in the stripper, far enough to cover the large hole *A* in the die, a piece of the stripper being cut away as shown to enable the operator to see when it is at the proper place, this being shown on the drawing by line *C D*. Having tripped the press, the operator passes the stock along until it reaches the finger gage, which is not shown here, it being attached to the press itself; the hole *E* in the stripper allows the finger to operate the

Fig. 3. These assembling and riveting tools are shown closed up, and with a staple in position ready to have the blank put on, and riveted. In operation, with the tools in the open position, the staple is placed in position, and the dies closed by means of the cam *A*. As will be seen the construction of the dies is simple, but at the same time very effective. Die *B* is fixed to the bolster *F* by a single screw *C*. Die *D* is furnished with two pins of drill rod, driven in as shown; these pins serve to aline it with *B*, and also the springs shown abut against them, thus opening the dies when the cam is moved from right to left. The cam is held in position by its lower part which engages with *D*. From this it will be understood that the dies and cam are all held in the bolster by the screw *C*.

With the staple in position the blank is placed on its reduced ends, the punch is brought down and its lower part being furnished with four strong springs, forces the blank onto the shoulders of the staple; as the ram moves further down, the punches *E E* come in contact with the ends of the staple which project far enough through the blank to form a rivet. The ends of the punches are concave and have a cross-like chisel arrangement which forms a very effective rivet. In the drawing Fig. 3, *G* is the punch holder and *H* the pressure plate which is fixed to *G* by two screws. No springs are shown in the end elevation of the punch part.

Originally these staples themselves were made on a small lathe with a cross slide carrying two tools, a reducing tool and a cutting-off tool. They were then bent to shape in the press. This method sometimes resulted in the production of staples which had one leg longer than the other and although none were bad enough to reject it was felt desirable to adopt some means of producing more uniform results so, when a wire-forming machine was installed the staple job was turned over to it. The fixture, which is shown in Fig. 4, was then designed for reducing the ends of the staple. From the drawing it will be seen that the fixture consists practically of two parts, which may be called the lower, or indexing part, and the upper, or holding part.

Taking the indexing part first, it consists of two principal members *A* and *B*, both of which are of gray iron. *A* is recessed in its upper face and *B* is fitted to the recess and held in position by the central shoulder screw. At one side of the recess in *A* a hole is drilled and a piece of drill rod *C* is driven in. On the underside of *B* a portion is milled away on both sides equal to half its diameter, plus half the diameter of the drill rod.

The holding part is made up of two pieces of tool steel *D E*. Through *D* and into *E* four holes are drilled as shown in the elevation at the right hand; into these holes four pins are fitted, a force fit in *E*, and a sliding fit in *D*. Also, in the holes in *D*, are four springs which, how-

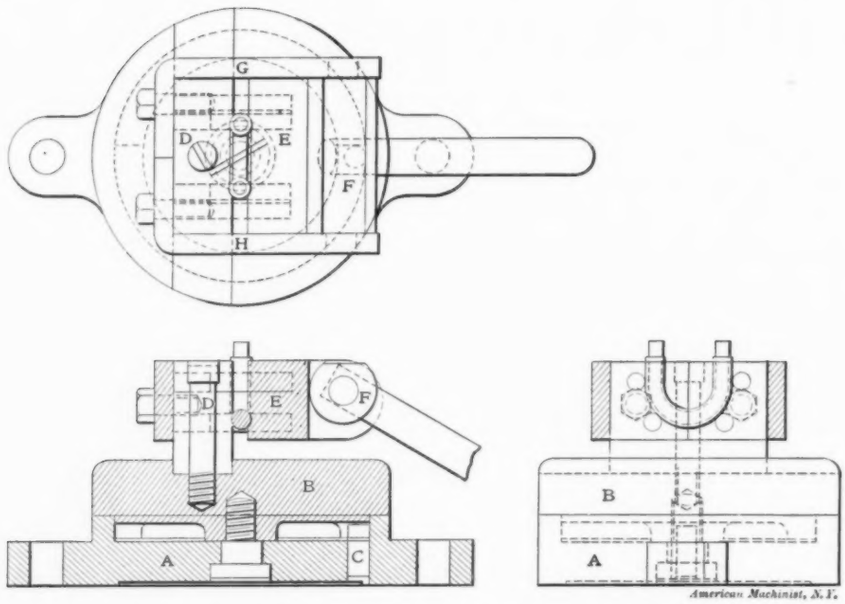


FIG. 4. FIXTURE FOR REDUCING STAPLE ENDS IN THE DRILL PRESS

ever, are not shown here, their duty being to open *D* and *E* when the cam *F* permits. Two angle plates *G H* are also secured to *D*. These serve to keep in the springs at the one end and carry cam *F* at the other. The piece *D* is a tight fit in the channel machined for it in *B*, and also is fixed there by a screw.

The four pieces of drill rod in *D* and *E*, besides grinding the part *E*, form the location of the staple itself; a seat was also formed on the adjacent faces of *D* and *E*, to prevent marking of the work, although later this was found to be unnecessary. In operation the fixture is set up in the drill press with one leg of the staple in line with the drill spindle, which carries a hollow mill, and with the part *B* abutting against the pin *C*. One leg having been reduced the upper part is revolved about its axis until the other face of *B* abuts against the other side of the pin *C*. The second leg will now be in the correct position to be reduced. From the drawing it will be seen that as *D* and *E* do not come close together, and as the work rests on the four pins there is no place for the chips to lodge and interfere with the alinement of the work, neither can anything get in between *A* and *B* as, with suds running on the work the chips will be washed away. The lever serves to operate the cam, opening and closing the dies, and also moves the dies from one position to the other; it is held by the operator in the two positions with one hand, while the hollow mill is advanced by the other.

London, England. W. L. FULLER.

Pulley Crowning Attachment

The attachment illustrated by the halftone, Fig. 1, which has proved very simple for the crowning of belt pulleys, was designed and constructed in the machine shop of Gebr. Heinemann, St. Georgen (Schwarzwald), Germany.

The principal part of the device is composed of three pieces: The tool holder *A*, the tool slide *B*, and the lever *C*. The tool slide *B* must have a small amount of motion to and from the work, or pulley, while the entire attachment moves across the face of the pulley in the direction of its axis.

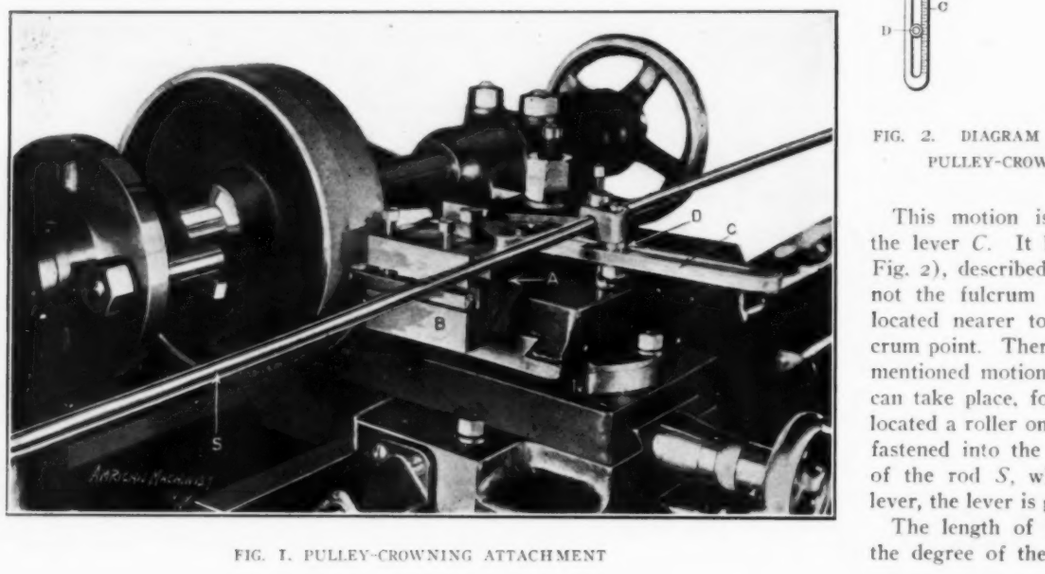


FIG. 1. PULLEY-CROWNING ATTACHMENT

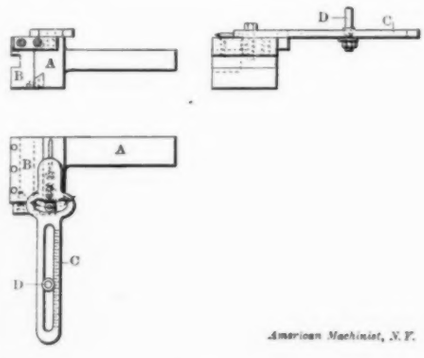


FIG. 2. DIAGRAM OF PRINCIPAL PARTS OF PULLEY-CROWNING ATTACHMENT

This motion is accomplished through the lever *C*. It has a circular slot (see Fig. 2), described from a center which is not the fulcrum point of the lever, but located nearer to the slot than the fulcrum point. Thereby, it is seen, the above mentioned motion forward and backward can take place, for in the circular slot is located a roller on a suitable stud which is fastened into the tool holder. By means of the rod *S*, which is fastened to the lever, the lever is given a swinging motion.

The length of the motion and thereby the degree of the pulley crowning is de-

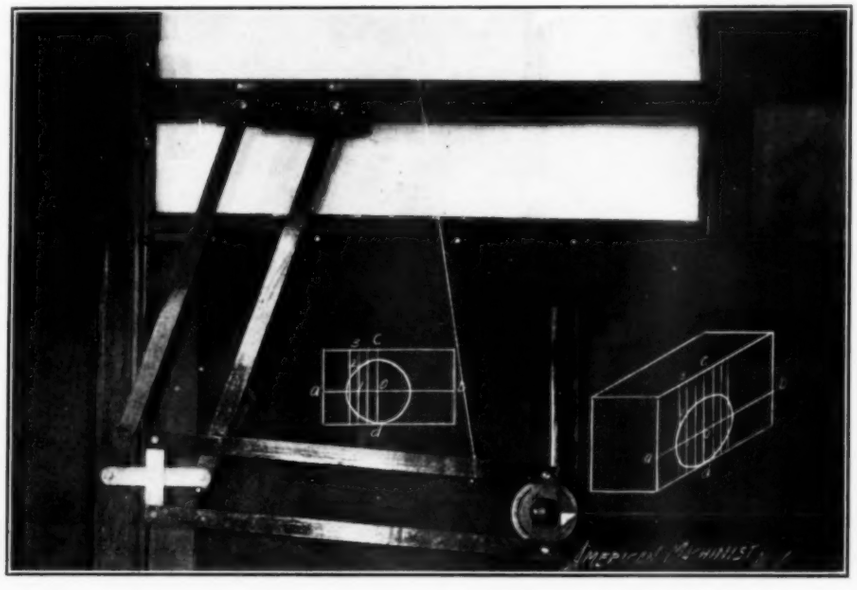
termined through the setting of the stud *D* in the graduated slot in the lever.

GEBR. HEINEMANN.

St. Georgen, Germany.

A Blackboard Drawing Machine

A few years ago an instructor in drawing and other engineering subjects felt the necessity of a means of accurately representing objects and diagrams on the blackboard. The machine shown in the accompanying photograph was therefore, designed and built and has proved very satisfactory for such work. It is made almost entirely of wood, the cross piece and connecting screws being of metal. The wooden disk, to which are fastened the graduated scales, is divided on the front face to every five degrees and can be loosened and adjusted by means of the large knob shown in the center. A string attached to the upper horizontal arm near the disk passes to the ceiling and over some small pulleys and has a counterweight just sufficient to balance the machine. The upper ends of the vertical arms are attached to a board which is hinged to allow movement out from the blackboard when it is necessary to move from one portion of the blackboard to another. This machine has been found exceedingly useful in such subjects as descriptive geometry, where the successful demonstration of a problem depends on



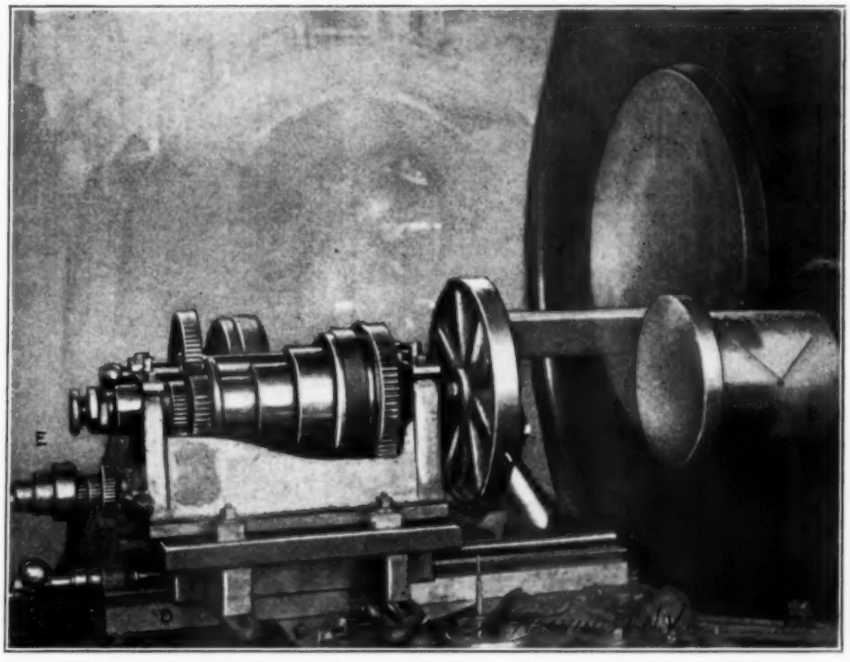
BLACKBOARD DRAWING

the ability of drawing lines parallel or perpendicular. Since designing and building this machine, which was some years ago, I have noticed that the makers of a drafting machine have arranged their machine so it can be used in a similar manner. The vertical graduated ruler is about twenty-two inches long, which will give an idea of the other dimensions of the machine. The pivot pins of the vertical arms are ten inches apart and those of the horizontal arms eight inches apart. This gives a sufficiently rigid construction. The arms are of hard maple $\frac{3}{8}$x2$\frac{1}{2}$ inches. It appears from using the machine that arms two inches wide would be rigid enough. The graduated disk is seven inches in diameter and is cut away on the front face so the bearing comes on the outer rim, thus giving large resistance to turning. The knob is of wood, three inches in diameter, and with a metal center threaded for the square-headed bolt coming through from the back of the disk.

Bozeman, Montana. GEO. B. COOPER.

Truing Up a Bent Wristpin

Not long ago our engineer attempted to start his engine, the shaft went halfway around and stopped suddenly. Upon investigation we found that he had neglected to let the water out of the cylinder. We also found that the crank disk which was



TRUING UP A BENT CRANK PIN

keyed to a 19-inch shaft was sprung to such an extent that it required extensive repairs. The key used in the disk was only two inches square, whereas it should, for that size shaft, have been five inches wide by three inches thick, or two keys two and a half inches square should have been used on opposite sides of the shaft. The disk had been shrunk on and could not be removed, so to make up for the deficiency in keys, we drilled six holes, half in the shaft and half in the disk, to a depth of 12 inches. We tapped these the full depth with a 1-inch standard tap, forced long screws into these holes and then cut them off flush.

The wristpin was also bent so badly that it had to be trued up and to do this we took the saddle and table from a plain milling machine and attached it securely to the bed of the engine in such a position that when the head of a "Blaisdell" engine lathe was fastened to it, it would be in line with the wristpin, but level and square with shaft of the engine. The wristpin was eight inches diameter by 12 inches long. A bar of suitable size and length was fastened to the faceplate of the lathe. In the end of the bar was a slot into which was inserted one of the various tools necessary to do the job. We also faced the inside shoulder of the pin as well as the pad on the crank disk, all of which was done in a very satisfactory

manner. We would have saved considerable time and hard work if we had drilled the holes in the end of the shaft and milled off the ends of the screws we forced into them, with a lathe head, but this did not occur to us until they were all drilled with a ratchet drill.

We used an electric motor to drive the spindle of the lathe and the screw of the milling-machine table for feeding the lathe head forward and back. Referring to the illustration, *A* is the crank disk, *B* is the wristpin, *C* is the saddle of the milling machine, *D* is the table, *E* is the lathe head, *F* is the turning bar attached to the faceplate of the lathe.

The motor, which does not show, is on the floor. It is belted to a countershaft and thence to the lathe head as shown. It is obvious that this contrivance can be used to good advantage on many other repair jobs.

Dayton, Ohio. H. E. CURTIS.

Two Carriers and a Burnishing Tool

Illustrated herewith are some of the many special tools we have made and found very useful in the Southern Pacific Railroad shops at Los Angeles, Cal. First, we have a driving-box carrier, which has proved a great favorite in the moving of driving boxes from place to place about the shop, as necessity requires while being handled by the different departments. Anyone who has tried to handle a driving-wheel box on the ordinary shop truck knows what a hard job it is and will soon appreciate the use of a carrier of this kind. It has another advantage, in that it can always be found, for it can be used for no other kind of trucking. This carrier was suggested by machine foreman C. J. Herbocker, and designed by general gang foreman G. H. Goodwin.

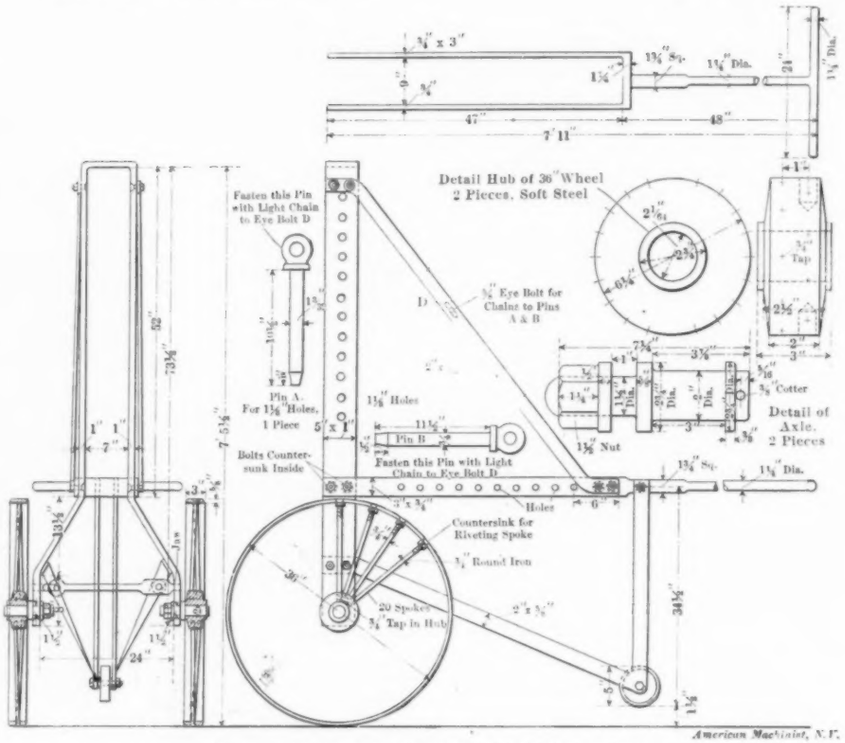

Detail Hub of 36" Wheel
2 Pieces, Soft Steel
Fasten this Pin with Light Chain to Eye Bolt D
¾" Eye Bolt for Chains to Pins A & B
Pin A
For 1⅜" Holes, 1 Piece
Pin B
1⅜" Holes
Bolts Countersunk Inside
Fasten this Pin with Light Chain to Eye Bolt D
Holes
Countersink for Riveting Spoke
¾" Round Iron
20 Spokes
¾" Tap in Hub
Detail of Axle, 2 Pieces
1⅜" Nut
¾" Cotter
American Machinist, N.Y.

FIG. 2. WAGON FOR CARRYING LOCOMOTIVE TIRES

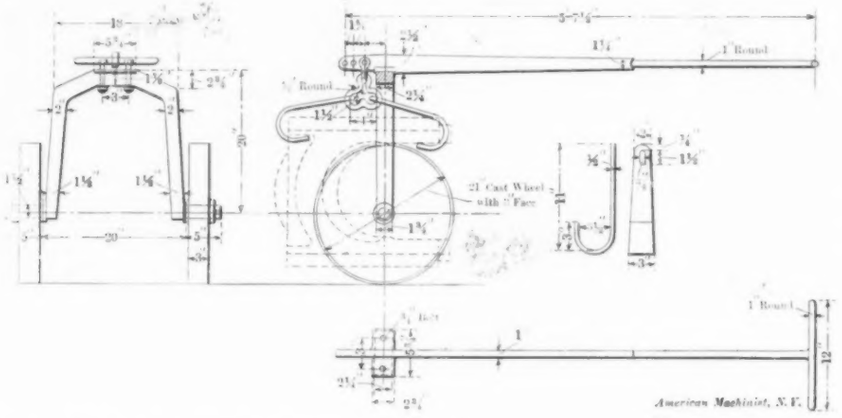


FIG. 1. WAGON FOR CARRYING DRIVING BOXES

CARRYING DRIVING-WHEEL TIRES

Then we have a driving-wheel tire carrier, which was also designed by Mr. Goodwin, and while it was not the first ever built, we have never seen one illustrated and it may help some of your readers who have much of this work to do. This carrier and a tire of the largest size can be handled with ease with three or four men, while the old method of rolling tires requires six or seven men, with the ever present danger of injuring some one. The drawing gives in detail all that is necessary for the building. As will be seen, the wheels are built up and can be made in any shop. Our carrier has been in service over a year and the wheels are in just as good shape as when built. The tire is hung on the pins shown.

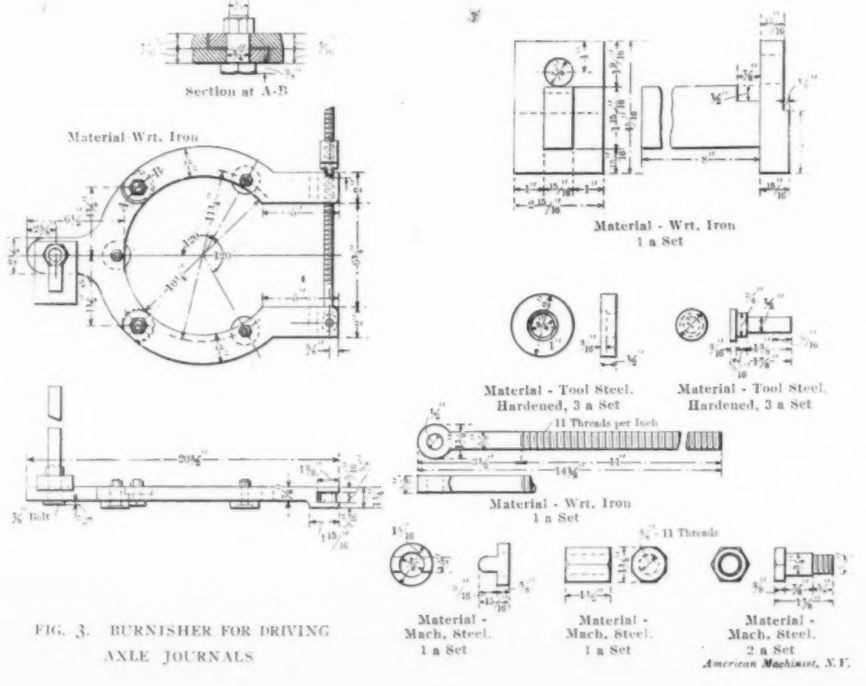


FIG. 3. BURNISHER FOR DRIVING AXLE JOURNALS

A Rolling Tool

Next we have a burnishing tool for driving-wheel journals, with three rollers, designed by Mr. Herbocker. Most roller burnishers are set in a jaw, making it useless for burnishing next to a shoulder. This tool overcomes this difficulty by putting all rollers on the outside of the frame and thus allowing the rolls to go into a corner without any trouble. A smaller tool of the same style has been built for burnishing piston rods and both are giving excellent satisfaction.

Los Angeles, Cal. Elmo N. Owen.

An Improved Gooseneck Tool

The tool herewith illustrated I have used for some time, and have found it much superior to the old form as usually made. Instead of only one cutting point, any number of points can be used in the same tool, adapting it for many uses where the ordinary gooseneck is not commonly used. The life of the common tool is limited to the length of time the one point will last, and then a new forging must be made, and all the work done to produce a new tool, while with this new form—while it costs a little more to make in the beginning, only the cutting points have to be renewed. For thread cutting it has greater stability and less liability to spring away from the lead and distort the thread angles. Within certain limits the spring forming the neck of the tool may be adjusted to suit the differing conditions under which such a tool must often be used. As a cast-iron finishing tool it is superior when used with a cutter having a broad point, and cast iron may be turned or planed with it leaving a finely polished surface without the use of files or emery cloth. For turning fillets on either cast iron or steel, I have found it better than the tools commonly used for this purpose, as it will not chatter when taking a broad cut, and for small fillets the cutting point may be ground to the exact shape required with the certainty that a better job will result.

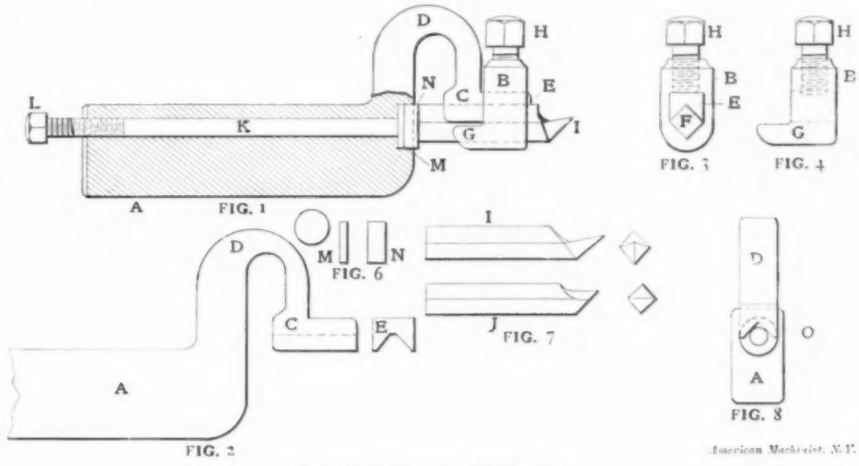
Fig. 1 shows a side view of the tool partly in section. Fig. 2 shows a part of the forging which will be seen to, in general, resemble the old form of gooseneck, but at the front end has an extension *C* which might be readily taken at first sight to be the cutting point. This projection, however, has a V shaped in its under side to take one-half of a piece of high-speed steel (I use 5/16 square).

In Fig. 7 this cutter is shown at *I* as ground for a thread tool, and in *J* as ground with a broad point for cast-iron finishing. These will illustrate the idea.

The base of this cutter abuts on a thick leather washer *N*, made slightly larger in diameter than the end of the cutter, and resting in a recess counterbored into the tool body, as shown in Fig. 8 at *O*, which is a front view of Fig. 2 after the V has been planed. At the bottom of this recess is fitted a steel washer, as shown at *M*, in Fig. 6, resting against a drill-rod shaft which extends through a hole made parallel with the shank of the tool, the set screw *L* having sufficient movement to take up successive grindings of the cutter points when worn up to the holder *A*. The blade *I* is clamped in position on the point of the holder *A* at *C* by a bridle made of tool steel (left soft), as shown in Figs. 3 and 4. In Fig. 3 the location of the end *E* of the holder *A* is shown, and the square hole in which the cutter fits is shown at *F*. The side walls of the bridle, as shown at *B*, should be of sufficient thickness so they will not break from the strain caused by the set screw *H* in clamping the blade *I* into the V on the holder, and at the same time not unduly heavy as it will interfere in cutting up to a shoulder. The set screw should be case hardened, and pains taken to make a good job of the whole tool as it will pay in the end. If so made, the blades may be taken out when cutting threads with the assurance that after being stoned they will come back into the proper location in the partly cut thread when replaced in the holder. While the spur *G* on the bridle may not be absolutely necessary, I have made mine that way so as to give a longer bearing for the cutter to rest on, and in conformity to the bearing on the holder at *C*. It may be unnecessary to add that the holder should be nicely spring tempered at *D* as is the usual practice with the old gooseneck tool, in finishing cast iron, the set screw *L* should be set well against the rod *K* after the cutter *J* is clamped to the holder, so that the neck of the holder *D* will exert a strong pressure on the cutter-blade base against the washer *N*. This should also be done in turning out fillets, or other broad-point work, such as finishing work in the planer or shaper. In thread cutting, I generally set the screw *L* well up in taking the roughing cuts, which will enable a surprisingly heavy cut to be taken without chatter or digging in, even on the softest steel, and after the thread is nearly done I take out the cutter, stone it carefully to the gage if it needs it, then replace it in the holder, slack off the screw *L*, and finish.

The resulting thread will be as accurate or better in this respect than can be produced with the old form of tool, and cut with a beautiful finish exceedingly difficult to obtain without the use of a tool of the gooseneck type.

Newark, N. J. George J. Murdock.



AN IMPROVED GOOSENECK TOOL

Value of American Machinist for Treatment of Steel

After the decrease of the late lamented brisk trade, which departed this life about October, 1907, it became necessary for me to find a new sphere of activity. Dropping into a shop one day to talk with a superintendent whom I had known some years, the talk ran to high-speed steels. He stated he had no use for them, his experience proving they did not give as good results as carbon steel. It seemed impossible to convince him that his method of treatment was wrong, neither had he communicated with the agent of the manufacturer to obtain his view of the subject, but he condemned the lot because of his failure. I asked him if he took the American Machinist and he said no; he used to.

When the American Machinist, on page 314, Part 1 of Volume 31, came out with the article, "The Treatment of High-speed Steel," I carried my copy to him to read. Calling some time afterward I found that the advice therein contained had resulted in the high-speed steel being put into use for tools, thereby effecting a considerable saving of time on a number of operations; but alas! my American Machinist had mysteriously disappeared. The super, however, did not consider it necessary to subscribe for the paper, a

single copy of which had proved of great value to him and a saving to the company whose interests he is supposed to have at heart.

In the summer of 1908 I had to call at a little machine shop in the country. The proprietor had a copy of the AMERICAN MACHINIST hanging by a cord, and I remarked: "That seems to be a sign of progressiveness." He said, "Yes; that's a very good number; it's got the way of treating high-speed steel, and I put it there to be handy when we have to do that kind of work."

What a contrast between the two men! It has always been a surprise to me how good toolmakers could overlook the many valuable features running in this paper from week to week, men who were getting from $3.50 to $4.50 per day, yet failed to see the obvious advantages in keeping posted in the progess of their own line.

South Acton, Mass. BEN ACCORD.

A Valuable Patent?

Did you ever put a perforated water pipe along the ridge pole of your house and when you saw a thunder shower approaching go out and turn the water on so the lightning wouldn't strike the house? No? Well, did you ever line the roof of your house with electric fans so that when you heard the muttering of thunder in the distance you only had to turn a switch to send a riot of breezes boisterously galloping over the aforesaid roof for protection against lightning? Crazy? Oh, no, the trouble is with you. You need to take lessons from the American patentee. Your education has evidently been sadly neglected. You ought to know that the hot sun beating down on a roof is the cause of a column of hot air rising from such roof, and hot air being rarefied, such a column offers a path of least resistance to any lightning that may be lurking near.

Don't think, however, that you will try one of these schemes, or take your garden hose to break up this dangerous column of hot air the next time you see a thunder storm swooping down upon you and your little brood, for if you do you may be sued for infringing a recently issued United States patent which describes both of these methods. The first claim reads:

"The method of protecting buildings from lightning, consisting in keeping the roofs thereof cool."

Old Pluvius often sends some rain along ahead of the lightning in the ordinary course of his business. What will he do now? It looks as if he would have to prove previous invention, or a two years' public use, or else give up this part of his program for the next seventeen years.

The lightning-rod man is gone, but here is his successor close on his heels.

Lowell, Mass. J. D. K.

Grinding the Lobes on a Cam Bolt

This fixture is for setting and holding a diamond to shape emery wheels to any arc from zero up to 1½-inch radius for the purpose of grinding the lobes of cam bolts.

Fig. 1 is a cam bolt made of machine steel case hardened. The variation in the lobes after hardening is considerable, and it is necessary to grind them to make each act alike.

We will now set up a cutter grinder to grind such a cam bolt as illustrated. The arc is a segment of a one-inch circle.

First of all we shape the emery wheel; which is done in the following manner: Set *C* so that the graduation mark *1* lines up with the zero mark on *A*. Then put the diamond in *A*, seeing that the diamond point rests on *C'*, and lock with the set screw *B*. Take off *C*, and bring the diamond in contact with the emery wheel, using the screw *D*. Swing the diamond slowly and keep it in contact with the emery wheel until it has been shaped. Leave the diamond in the fixture, for it is necessary to true up the emery wheel from time to time. The next thing to do is to put the cam bolt between centers and connect it to the index plate by a special dog. Line the cam bolt up with the emery wheel, make one cut across and back and then index on to the next lobe and so on, until finished. The cam bolts ground in this fashion vary in size from ⅜ to 3 inches in diameter, and the number of lobes increases with the size of the cam bolt.

E is for lining up the fixture with the different-sized emery wheels.

New Haven, Conn. JOHN R. JARVIS.

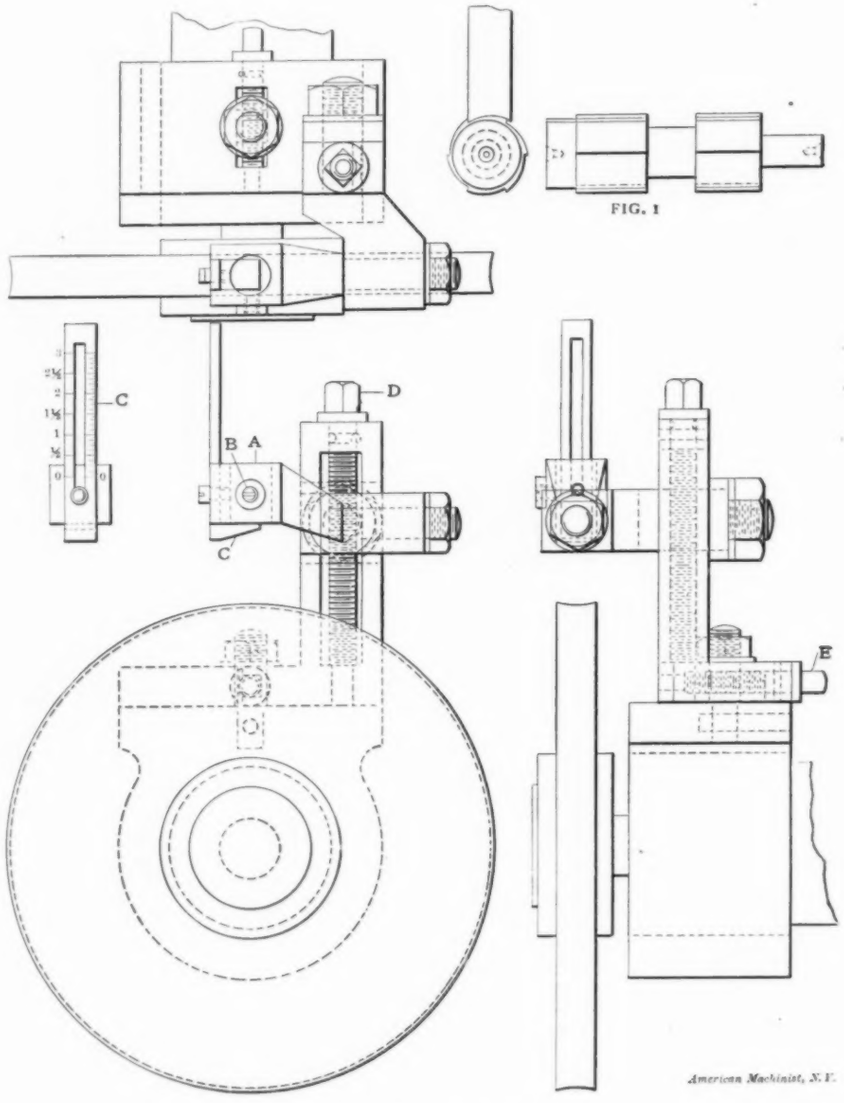


FIG. 1

GRINDING THE LOBES OF CAM BOLTS

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Automatic Train Stops

I have read your article by Mr. Redfield, on page 278, describing an interlocking switch and signal plant, and would like to add a little to it. In the last part he speaks of the automatic lever for "breaking the train pipe" which sets the air brakes. This works all right on an electric railroad, where the simple act of taking the hand from the controller cuts off the power. But what would happen if the air brakes were set on a heavy steam train and the power not shut off?

Another thing which seems strange is that there is not a national or even an international law requiring signals on all roads to mean the same. A man knowing the signals thoroughly on one road is useless on another. Take the case in the article which refers to the Central Railroad of New Jersey, which uses white "clear," red "danger," and green "caution." The Interborough uses green "clear," red "danger," and yellow "caution."

White is also used as a danger signal, both in the interlocking plants and as a hand signal. I understand the reason for this latter is that if a glass were broken in a signal box, say, a "caution" yellow, it would show white "danger," or if a red were broken it would still show danger. On the Central of New Jersey if a red were broken it would show white, meaning a clear track.

Another thing, and one which shows how delicate is the system, is that the breaking or short-circuiting of a wire will hold up a train. The laying of a piece of metal across the rails will also bring a train to a stop.

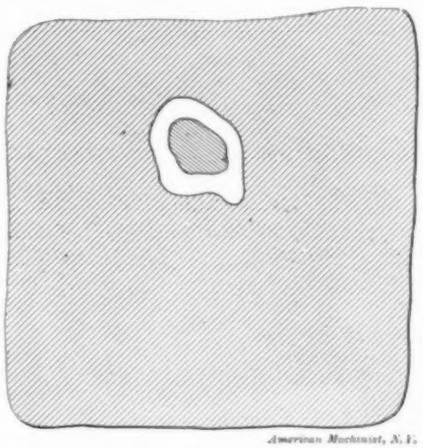
New York City. HERMAN JONSON.

[The effect of applying the emergency brake on a train drawn by the most powerful steam locomotive would result in almost immediate stoppage even if the steam were not shut off. At high speed this would probably result in pulling out almost every drawhead, but it would nevertheless accomplish the desired result: stop the train. Furthermore, this serious damage to the rolling stock would make every engineer extremely careful to obey signals.

As to a uniform system of signal-light colors, red danger, green caution, and white clear constituted the original generally adopted plan. Since then some railroads have thought to improve upon this by the substitution of other color schemes for various reasons, some of which Mr. Jonson himself gives. All the different railroad signal men have not agreed as yet as to which system has the most in its favor, hence the lack of uniformity. At some future time there is no doubt that some one scheme will be decided upon as the best and will then be uniformly adopted.—ED.]

Melting of Steel from the Interior

In the AMERICAN MACHINIST on page 972, Mr. Blackiston introduces to us *his* recent discovery, viz., "that steel, contrary to the general belief, invariably melts from the interior." So far, at least, as Mr. Blackiston is concerned, his "discovery" is not a very good illustration of Lemierre's great saying. The *recent* discovery was probably made by the first observant steelmaker who turned out a *defective* pot before the steel was quite melted. This is a frequent occurrence and, therefore, the subject of the note referred to must have been discussed more than half a century ago. At least it was known thirty years ago in the furnaces where I worked as a boy.



SECTION OF INGOT SHOWING SUPPOSED "INVARIABLE CONDITION"

Mr. Blackiston is also not justified in saying that the steel invariably melts from the interior; it does not.

In the manufacture of steel by the crucible process there is a state known as, "over head," that is, to say when the melted portion entirely covers the pieces remaining unmelted. After this stage is reached any piece got out of the pot will be solid, and, if left in the pot, each piece will melt from the outside. I have seen scores of pots turned out on the furnace floor at this stage, but have never once found a hollow piece among those which were unmelted. I have also seen a great number of ingots cast when the pot has been well "over head," but not thoroughly melted. Such ingots are always broken up and should, if Mr. Blackiston's contention is "invariably true," always show a cell of the unmelted charge filled with the melted material, as indicated in the cut herewith, whereas the unmelted pieces are, so far as my observation goes, always solid. If hollow pieces are found it is always before this "over head" stage is reached. This, according to paragraph five of the article referred to, appears to have been the state of the charge in which Mr. Blackiston found the hollow pieces.

After reading Mr. Blackiston's article I looked over the scrap heap and found two pieces of steel scrap fused together; one of these had melted from the inside, but the other was fully half melted away from the outside, so that one might infer that the melting does not invariably proceed from the inside even when the scrap is not fully immersed in the bath.

With the explanation given of this curious behavior I am quite in agreement. When, however, Mr. Blackiston states that he does not know if this is true of the bessemer process, not having tested it to his entire satisfaction, he is somewhat unintelligible *as the converter is always charged with the molten material.* If, however, he refers to the addition of scrap to cool down the blown charge, then it is quite certain that the melting proceeds from the outside.

Sheffield, England. A. W. B.

Mathematics and the American Machinist

Your editorial, on page 172, on this subject, seems to be compelled by a misunderstanding. Since the misunderstanding is one of long standing and general acceptance it will probably be a long time before it is straightened out, but the attempt is worth while. The difficulty that I refer to is that most people look on mathematics as an end instead of a means. This applies equally to those of your readers who object to your mathematical articles and to the professors of mathematics in our technical colleges.

Mathematics, as it is taught, is something weird and fearful and surrounded with deep mystery. This state of affairs may be due to either one of two reasons:

one, that the professor does not know his mathematics as a means to an end, the other, that he feels that the traditions of his profession demand that a certain degree of mystery should surround his work. Either reason will account for the lack of sympathy which you undoubtedly find between technical graduates and mathematics. When you see a professor considering a certain problem in mathematics for two or three weeks and consulting half a dozen brother professors as to how to do it, and then putting it on an examination where the student has less than an hour for its solution, you can also see that there may be a dormant dislike for too much mathematics in certain quarters.

For my part, I have been up and down the hill. I was taught mathematics just as everyone else is taught. I liked it pretty well, but as soon as I got out in commercial life I forgot as much as possible. Then I found that I needed some of it, and then more and more. Ultimately I evolved a mathematical knowledge that stood me in good stead, but which would have shocked my professors. It was not a rule-of-thumb mathematics, but it was based on the idea that I could *use* logarithms without remembering how they were built, and that I could use trigonometry and yet not be able to compute the table of sines, and that I could use calculus with the aid of a good book of integrals.

After all this I shall have to confess that when I see a mathematical article in your columns that otherwise interests me, I skip the algebra, etc., and read the author's conclusions. If they look reasonable and the thing is something, as is almost invariably the case, that many others will be interested in, I wait a few weeks and see if anybody gets up and walks all over the article. If the author's conclusions do not look reasonable, I go over the mathematics with a fine-toothed comb without waiting for someone else to find the error, if any there be. I imagine that there are many others who think the same way, that the mathematical work should be there as an earnest of good faith, and that the reading of the mathematics itself may be safely left to anyone of the army of mathematical buzzards that are hovering around the editors in hopes to pick a flaw.

So much for the technically educated reader. Now, for the noneducated ones. Many of them will likely say that you might as well publish a page of Sanskrit as a page of calculus. Just as in the other case, it is true, but the author's conclusions in nine cases out of ten are stated in terms which require only a minimum of knowledge, and knowledge which any man likely to take even a general interest in the AMERICAN MACHINIST can readily acquire. Take, for example, Mr. MacGregor's article on page 1057, Part 1, of this year, on tests of steel wedges. In conclusion at the bottom of the page he gives a formula

$$F = \frac{W\,(sin.\ \phi - tan.\ \alpha \times cos.\ \phi)}{cos.\ \phi + tan.\ \alpha \times sin.\ \phi}.$$

This looks as serious to the uninitiated as almost any conclusion that has appeared lately, but if a man realizes that *sin.* ϕ and *cos.* ϕ, etc., are simple numbers which can be read out of any handbook, and that the form of the expression is simply an easy way of expressing or indicating certain arithmetical operations to be performed upon these amounts which he looks up in his book, then it all becomes very easy. And, as before, if there is anything wrong about the article some one will pounce on it shortly, and save him the trouble of doing it for himself.

Certainly there is no doubt but that algebra, geometry, trigonometry and calculus are absolutely essential tools for the engineer, just as precision measuring machines are necessary to the machinist who builds astronomical instruments. The machinist who limits his needs to a pair of micrometers corresponds to the engineer who omits calculus from his education, and so on down the list until the man with only arithmetic is pretty nearly at the bottom.

Springfield, Mass. ENTROPY.

Hardening Die Sections in the Lead Bath

F. J. B. says in his objections to the lead bath, on page 987, Part 1, that he has been in trouble more than once with die sections and punches that have been heated, for hardening, in the lead bath, and would be glad if I would show how the trouble is to be obviated, and that he has other pieces that the argument will apply to.

I do not care to enter into a discussion but think I can show him a solution of the problem. He states that one set of punches shrank as much as .002 inch at the face, and that it thickened so much in the middle, they presented a barrel-like appearance to the eye and that this was evidently caused by being immersed in the lead up to the point *A B*, Fig. 1; that before the region of *C D* had reached the hardening heat the face of the punch was too hot, and that this inequality of temperature is increased the shorter the punch and the greater the area of the face. Also that the face of the punch shrinks because it is too hot and that the middle expands because it is not up to the full hardening temperature.

Then he fears that I will tell him to immerse the entire punch, and warns me that this will defeat the very object of using the lead bath, and to do so we might as well heat it in a furnace, and that he has generally found the lead bath in use for local heating.

Now let us turn to his first statement. We must know that he used the micrometer to find the .002 inch of the punch, but as to the part that presented a barrel shape, we will have to guess at it. Judging from the measurement he gives of ¾ inch from the face to the lines *C D*, his punch must not be more than 7/16x1¼ x2 inches. A punch so small as this and to act as he states it did, swelling in the middle must have had a pipe in it and when heated, produced sufficient gas to bulge the sides.

The reason he gives "that the face of the punch being too hot before the lines *C D* get to the hardening heat," is where the very common mistakes are being made. A lead bath should never be any hotter than is desired for the proper hardening of the tool when quenching it and thus the face of the punch would not get too hot.

Remember that this fire becomes as poor a fire for the heating of steel as there is on earth, the moment it becomes hotter than the best hardening heat for the tool. There is absolutely just as much excuse for dipping a delicate tool in water when the tool and steel were both intended to be cooled in oil. One is just as far from being correct as the other, yet we find men practicing this and willing to blame their appliances or steel when in reality the fault is all their own.

Tools hardened in this way should never be measured with any tool other than a caliper rule. Sixty-fourths would be entirely too close a measurement to compare with the treatment that the steel has received.

Now let us turn to the proper treatment of a tool of this kind, and the reader will remember that in considering the method to be pursued that the tool is to be measured with a micrometer and that this tool is supposed to come from the hardening room ready for use without grinding. Of course this will warrant the proper equipment for the hardening of this tool. I will say, however, that the tool should be hardened without a fixture, with perfect success, yet it seems that F. J. B. has tried this and failed, so we must help him.

It will be necessary to make a cap to cover the punch to the line *A B* and fasten it on the punch, with a set screw as shown in Fig. 1. Then take a piece of the steel that the punch is to be made of and nearly the same size. Have the lead bath heated to what we consider just sufficient to harden the punch to the center. Then place the tool in the lead bath and leave it there until it becomes as hot as the lead. Then cool under water pressure with a stream on two sides at least, as this is the proper way to cool a punch where accurate results are desired.

Then break the test piece and if it has a fine silky grain to the center, you have the correct heat. If the grain is fine around

the edge then the heat will have to be raised. But if the piece is hard and shows a coarse grain, the heat will have to be lowered. Should the work required of the punch be light it will not be necessary to harden to the center.

Considering that we now know the heat and have the fixture, we are ready to heat the punch for hardening. Having the cap fastened firmly and tongs to handle the piece with, we place it in the lead to heat after providing a tank for the cooling as shown in Fig. 2.

As soon as the piece has become as hot as the lead, we take it from the fire and place the part that is expected to swell between two streams of water entering about 2 inches below the surface of the quenching bath as shown in Fig. 2.

The cap or fixture will prevent the cooling of the part that is desired to be machined, after hardening, and it will not need any protection other than the fixture which will permit the punch to be entirely submerged. The streams of water should be very close to the top of the water in the tank so as to strike the part that is expected to swell before the corners cool.

This distortion or swelling like a barrel, is caused by its having four corners and two projections that will cool ahead of the center. When these corners cool they become shorter, and as the center and outside cools it swells, and it will continue to get shorter and larger until the heat has spent its force or becomes overcome by the rigidness of the steel.

Hence, if we force the cooling in the spots where it cools the slowest, and extract the heat as rapidly from that point as it is extracted from the corners, we have a punch that will not need any grinding nor will it give any trouble in the assembling.

If we should take a piece of a ⅛-inch drill rod and heat it to the hardening heat in lead or any fire and extract the heat very rapidly when quenching, we would find it considerable longer than it was previous to hardening. Then if we should take another piece of the same bar, and cool it in oil, it would stay nearly as it was previous to its hardening.

Surely we cannot condemn our fires for this action of the steel. F. J. B. is quite correct in his statement that lead is used for local heating, or heating to an absolute point, and this is why I think it possible to harden the punch without a fixture, and submerge the entire tool. It is well to remember, when cooling a tool, that steel has a natural course which it pursues in the cooling. Where the piece is cooled, as we are obliged to think he did it, without any force from the water, we will get a piece actually staved up by its own force unless we change, or overpower its natural tendencies. In regulating the cooling we are able to produce what we want, rather than to take what we get.

Davenport, Iowa. C. U. Scott.

Dimensioning Detail Drawings—Limits for Threaded Work, etc.

To manufacturers engaged in the production of interchangeable parts and to those who are held responsible for the production of parts on the interchangeable plan, the article by P. H. Henning, at page 166, on "Dimensioning Detail Drawings," cannot fail to be of interest.

No one, I think, will deny the advantages gained by manufacturing on an interchangeable basis, when we have before us such examples of production as sewing machines, firearms, typewriters, cash registers and adding machines with their many parts, all made on the interchangeable system. Now, the manufacturers of these articles could not produce them as they do without an extensive use of the limit-gage system, and having long recognized the fact, all of their gages are made on this system, but, as there is no generally recognized limit for any of the various classes of fits required in the various lines of mechanical products, no two makers have the same limits, and consequently the cost of making the necessary gages must be very high, as they cannot be purchased of the gagemaker as stock goods, as would be the case if there were established limits for the different classes of work in mechanical operations.

A number of years ago Professor Sweet was assailed with criticism for pointing out some of the mechanical deficiencies in this country as compared with Great Britain and the Continent, and believing that a comparison can again be made to our advantage, this time on the subject of officially established limits, would say a few words to that effect.

Quoting from the "Fourth Report on Work Accomplished" by the Engineering Standards Committee of Great Britain: "In January, 1901, on the motion of Sir John Wolfe Barry, K. C. B., the council of the Institution of Civil Engineers appointed a committee to consider the advisability of standardizing various kinds of iron and steel sections. Thus began the Committee, which is supported by the following: The Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, the Institution of Electrical Engineers, and having a main committee under whom there are 12 sectional committees, appointed by the main committee, and 28 sub-committees, appointed by the sectional committees, with a total membership of 284.

"The sectional committees consist of representatives of the various government departments, of consulting engineers, manufacturers, contractors and users, and representatives of the technical societies and trade associations interested in or affected by the subjects under consideration."

Among the many subjects on which reports have been issued giving definite limits are the following: Report on British standard systems for limit gages for screw threads; British standard specification for steel bars for use in automatic machines; report on British standard systems of limit gages for running fits; and there is also under consideration at the present time the question of high and low limits for the pipe threads adopted in their report on British standard pipe threads for iron or steel pipes and tubes.

From the foregoing it is seen that the question of limits is receiving a great deal of consideration, and it will surely redound to the advantage of the manufacturer, in full measure.

In our country the only cases in which limits have been officially recognized are the following: Limits for round iron; worm coupler and wheel-defect limits; flange-thickness limits; limits for automatic couplers and new knuckles; limit sizes for machine screws; the first four having been adopted by the Master Car Builders' Association, and the last named being the American Society of Mechanical Engineers' new machine-screw standard.

Only lately there has been brought out the new screw and nut system adopted by the Association of Licensed Automobile Manufacturers, and while they are to be complimented on having adopted the U. S. standard form of thread, of how much more value would this action have been if they had considered and adopted definite limits for taps, dies, bolts and screws, so that the gagemakers could have carried in stock gages embodying the limits adopted by them.

While the adoption of a system of limits for work with a cylindrical surface has long been of unquestioned value and so recognized by every prominent manufacturer, the question of limits for threaded work has been neglected until the adoption of the standard approved by the American Society of Mechanical Engineers for machine screws, and with this one exception there is no other standard giving limits for its use.

In the consideration of the installation of a department devoted to the construction of gages at the factory of Wells Brothers Company, in Greenfield, Mass., much thought has been given to this subject of limits and the conclusion reached is that the manufacturer wants a gage with limits, and where no limits exist experiments have been carried out to determine the limits most suitable for the different classes of work.

I append herewith a table of the sizes and limits allowed in the case of the A. L. A. M. thread, these sizes being accepted by several automobile manufacturers and gages embodying them being supplied.

The designation of "Thread Micrometer Reading" is the reading taken with

the Wells Brothers Company's thread micrometer caliper illustrated and described at page 524, Part 1.

Plugs.				Templets.			
Size.	Threads Per Inch.	Thread Micrometer Reading.		Size.	Threads Per Inch.	Thread Micrometer Reading.	
		Max.	Min.			Max.	Min.
1/4	28	0.2273	0.2264	1/4	28	0.2259	0.2250
17/64	24	0.2765	0.2755	17/64	24	0.2749	0.2739
9/32	24	0.3436	0.3425	9/32	24	0.3419	0.3408
5/16	20	0.3938	0.3925	5/16	20	0.3918	0.3903
1/2	20	0.4564	0.4550	1/2	20	0.4543	0.4529
9/16	18	0.5108	0.5092	9/16	18	0.5084	0.5068
5/8	18	0.5734	0.5717	5/8	18	0.5709	0.5682
11/16	16	0.6255	0.6236	11/16	16	0.6228	0.6209
3/4	16	0.6882	0.6862	3/4	16	0.6853	0.6833
13/16	14	0.7999	0.7977	13/16	14	0.7968	0.7946
1	14	0.9253	0.9228	1	14	0.9218	0.9193

TABLE OF LIMITS FOR A. L. A. M. GAGES AS MADE BY WELLS BROTHERS COMPANY.

In conclusion, I would only say that the various mechanical societies could not do better than get together and adopt limits for various classes of work, as has been done abroad, thus giving the gagemakers a chance to stock gages according to the figures adopted and giving the manufacturers the benefit of the consequent reduction in price occasioned by making the gages in quantities.

Greenfield, Mass. F. C. Scribner.

Leveling Up a Lathe Bed

The illustration at page 226, showing a man leveling up a lathe by having a helper drive a wedge under one leg, reminds me of a story told by F. C. Pratt about an incident that occurred in the Pratt & Whitney works a few years ago. It was when they adopted their rigid box bed for their 14-inch lathe. A workman came into the office and said to Mr. Pratt, "I don't like that new lathe." "Why, Jim?" asked Mr. Pratt, and he said, "because I can't take it out of wind by wedging under the legs." It likely seemed as funny to Jim why anyone should ever build a lathe that way, as it does to me why everybody does not.

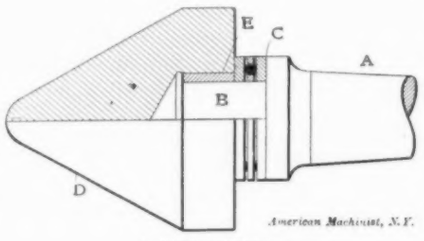
Syracuse, N. Y. John E. Sweet.

A Ball Bearing Pipe Center

The article on above at page 889 calls to mind a somewhat similar center recently made, for dealing with double bell-ended steel tubes, which had to be turned about so that both ends could be machined; in addition to this, there were three different sizes of tubes, none of which could be conveniently supported on the same center to enable both ends to be turned.

The center shown was therefore devised, and has proved both efficient and inexpensive, as the time required to change over from one size to another is practically nil.

The shank *A* is turned a standard taper to suit the tail spindle, and the nose *B* to take a set of ordinary ball thrust bearings with collars as shown, the back collar bearing on the face of the shank at the shoulder *C*. Three cones *D* were made to suit the different sizes of tube, these



A PIPE CENTER

being fitted with a steel bush *E*, turned to suit the bore of the cone, and ground after being pressed in position. For convenience in grinding the cone, the nose is centered, so that it may be ground in position, being driven by narrow belt on body. To change from one size tube to another, the operator simply changes cones.

Basingstoke, England. H. Pearman.

Shop Testing of Steel

In a recent article, Mr. Osborne tells us of Sammy's troubles on the high-speed steel question but does not give us Sammy's methods of testing it. The writer knows nothing about Sammy's methods but does know a little about the results at Blank's, Double Blank's and Triple Blank's.

In Mr. Blank's shop they do a great deal of drilling, mostly with high-speed drills. The quality of the drills was a vital question in shop economy and Mr. Superintendent decided to test them out. As each of four salesmen called they were informed of the great test soon to take place and were invited to send a sample 3/8-inch drill. The salesmen all complied, but were told that their presence on the great day was undesirable.

At last the day arrived. The man in charge had had some half-inch plates cast and had chosen an apprentice for operator. The plates were poorly cleaned and prick punched very unevenly. The boy started in, feeding by hand, his object being to see how soon he could spoil the drill. In the early hours of the day he put considerable pressure on the feed lever but as the day wore on, both he and the drill became tired and the result was, to say the least, very spasmodic feeding. As a result of the uneven prick punching many of the holes overlapped with the natural hard usage on the unlucky drill. At the conclusion there was a great difference in the results and one happy salesman hurried to Sammy with an account of his great success at Blank's.

At Double Blank's they were more interested in lathe tools than in drills. They had an order for six large nickel-steel shafts and although this material was very seldom used in the shop, they thought it would prove an excellent chance to test out their different tool steels. Three tools, as near alike as possible, were forged from different makes of steel. Each tool in its turn was used on the shaft. The feed and cuts were placed at hights unheard of in that shop and the results were varied. The worst showing was made by the steel that they had been using most. It only stood up for about three inches while the best showing was between eight and nine inches. Another salesman hastened to Sammy with the glad tidings. A while after this, out of curiosity, the assistant foreman had two more tools made. One was of the steel which had made the best showing, and the other of their old standard which had done so poorly on the test. He marked the tools secretly and gave them to one of his best lathe hands who had a long job ahead of him on cast iron. The man was told to use them alternately, but not to change until grinding was necessary but to note the amount of time that each tool was run. He was told to keep the same cuts and feeds with each tool and to keep to ordinary feeds and not try to do them up. After some time results were footed up and it was found that although each had had the same number of grindings, the old standby had been on the job about twice the time the other had and on this everyday work had done about twice the work of the test winner. The assistant foreman very nearly lost his job for reporting this to headquarters.

At Triple Blanks, they allowed no outsiders in the shops. Mr. Salesman had made repeated trials to get in but had always met with a refusal from the superintendent. One day he saw the gates open and walked in. He had seen about everything of interest and considerable of no interest when the superintendent saw him. He came over with a rush and wanted to know what in —— Mr. Salesman meant by coming in there after so many refusals. "I have'nt much excuse," was the reply, "but I understand now why you don't allow visitors. If I ran a shop the way you do, I too would be ashamed to allow visitors."

Chicago, Ill. B. J.

Machine Cut Double Helical Gears

Referring to the article on the above subject published on page 273, will you kindly publish the fact that I am the inventor of the gears and of the gear-cutting machine shown.

C. Wust.

Grand Union Hotel, New York.

AMERICAN MACHINIST

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The Opening of a New Epoch

These are the days when history is being made.

The events of the great aviation week at Rheims, France, must have convinced the most skeptical that the day of successful aërial navigation has arrived, and it surely is a day of great achievement in which it is worth while to be alive. It is not long since the attainment of human flight was a symbol of the impossible nor is it long since serious devotion to its achievement was looked upon as little else than evidence of a disordered brain.

It is everlastingly to the credit of the French people that they should have foreseen the possibilities of their great week and organized the exhibition, albeit its success must have far transcended the expectations of everyone connected with it. The record of it is one of wonders, in which marvel succeeded marvel. As one correspondent puts it: "We have to rub our eyes to allow ourselves to reach a realizing sense that what we have actually seen in the air here above Betheny's Plain, above the hills of Witry and Bourgogne, against the ancient towers of Europe's loveliest cathedral, has been no dream but a veritable fact. Never since history began have been witnessed such scenes of wonder, scenes pompous with human accomplishment and so presagent of a change in the life of man upon earth."

There is but one event in the past with which the week at Rheims may be compared, or as the future will look at it, which may be compared with the week at Rheims. We refer, of course, to the Rainhill trial of locomotives, when Stevenson's "Rocket" was victorious, and when the railway era was formally inaugurated; and the parallel between the two events is more than superficial, for each was the harvest day of a preceding seed time. The locomotive had been in process of development for twenty-five years previous to the Rainhill trial, which indeed saw nothing more than the assembling of preceding individual achievements. Not a single novelty in locomotive construction made its first appearance at that trial, and nothing was accomplished which might not have been fairly and confidently predicted by anyone familiar with the events of the preceding quarter century.

The week at Rheims parallels this exactly, except that the preceding period of development was much shorter because today events move more rapidly than they did a century ago.

There is, moreover, another point of comparison with the development of the locomotive, in which many men took part, so many, indeed, that it is difficult to identify the locomotive with any individual name—the one thing most certain about it being that the man who has received most credit for it—Stevenson—really deserves but little. So, too, many men have assisted in the development of the aëroplane and many have done notable work in its development, although among them all the name of the Wright brothers, "to whom no monument high enough will ever be raised," must always stand out preëminent for the magnitude of their achievements.

When the fundamental difficulty of this achievement and the many centuries during which it has been the dream of man is considered, the making of a successful flying machine must always be ranked far ahead of the making of the first successful locomotive, although when the influence of the locomotive upon the development of civilization is considered, the two may be fairly classed together regardless of what the flying machine may develop into, this indeed being for the present a sealed book, for we confess that we can form no idea of what it all means in the progress of mankind beyond the conviction that it means more than we can today conceive.

Not the least gratifying of the events at Rheims was the capture by Glenn Curtiss of the International Cup given for the fastest aërial journey. The terms of this contest insure that the next aviation week shall be held in this country, and the rapidity with which events are treading upon one another's heels in this field of work can leave no doubt that when the time arrives next year the American people will witness a spectacle that will electrify the entire country as the events at Rheims have electrified all Europe. And this is sadly needed, for the American people have been strangely apathetic in the face of the achievements of their own countrymen, the Wright brothers.

And it is never to be forgotten that this is but another glorification of the mechanic and the machine shop. The mechanic who does not realize that it is to such as him and his that the world is now looking, and to whom all this is due, and who does not with this before him, walk the earth with a prouder step, has failed to realize the deep significance of this piece of history making.

In this connection we may fairly refer to the coming Hudson-Fulton celebration which the present month is to see in this city—the grouping together in point of time of the inauguration of aërial navigation and of the celebration of the inauguration of steam navigation of the water being indeed most fortuitous, for as one is an exhibition of the most recent achievement of the machine shop, so the other is a glorification of a past achievement of that same great agent of civilization.

Our readers are aware, of course, that a duplicate of Fulton's "Clermont" is being prepared for the coming celebration, and of this they may look for some interesting illustrations in our issue of next week.

Rapid Power Traverse on Machine Tools

It is not always easy to determine just where to use a quick-power traverse or other movement on a machine tool and where to leave it off. We are, however, altogether too prone to err on the wrong side, as can be seen by noting the different machine tools that are now on the market. There are large milling machines and boring mills as well as radial drills in which it is necessary for the operator to either use the slow-power feeds or run them back by a handwheel or crank. In many cases the part to be moved weighs several hundred pounds and as a result the operator runs the gibs as loose as he dares, so as to have the bed or table run as easily as possible.

While it costs a few dollars to put on a quick-power movement, we believe it is soon repaid not only in the time saved, but in the quality of the work. Much better work is sure to be done, especially on milling machines and boring mills, if the heads are gibbed up fairly tight and yet when so adjusted they require more power than an operator should be asked to exert. Let anyone who doubts this try running the table of a milling machine or the head of a fair-sized boring mill back a couple of feet at a fair rate and see if they are in condition to do any fine adjusting of micrometer dials or other similar work until they have taken a few minutes' rest. Of course, men have done it, but it is not economy to do so.

There is also another phase to this question and that is the effect of the quick traverse on the movement of the operator. If anyone will compare the movements of operators on machines equipped with a quick traverse and those which must be moved by hand, he will note a marked difference in the speed which is almost entirely due to the effect of the quick power movement in the same way as a lively tune will induce fast marching or fast work. This can be easily proved by exchanging operators from one type of machine to the other and we are sure there will be very few exceptions to the above statement. It is exactly the same in effect as the pace maker in a race and it not only secures more work from the machine, but makes the operator more valuable to his employer, in addition to securing better work.

Send "Any Old" Catalog to the Foreigner

An occasional contributor to our columns, living in Germany, sends us this gem about American advertising: "An American machine-tool builder sent me a description of one of his specialties, in SPANISH! I happened to be able to read it, but why in the name of common sense does he send a Spanish circular to Dresden?

"It is true I once lived in New Jersey—but that was long ago."

For some months past we have been repeatedly told through certain channels that "the foreigner pays the tax," implying that the foreigner is fair game, and that any old thing will go where he is concerned. Apparently this same spirit has actuated an American advertising manager, who, saying to himself "any old catalog is good enough for the foreigner," has blithely sent a batch of Spanish catalogs to Germany. But, perhaps we are wrong. Perhaps Miss Maud, the private secretary of the aforesaid advertising manager, was much interested on a certain fine morning in her pleasant memories of the dance of the night before and merely mistook Spanish for German.

This incident is worthy of remembrance with the famous passage from a Spanish version of an American catalog, which, literally retranslated, referred to chilled cast iron as "iron with a cold."

Why should not the foreigner ask, "Why in the name of common sense do they do such things?"

It is, of course, unpardonable to explain a good joke; yet, as some of our good readers do not live in Philadelphia, we feel compelled to remark that New Jersey is colloquially referred to in and about the Quaker city as "Spain."

New Publications

SOUDURE AUTOGENE (AUTOGENOUS WELDING). By E. Chatelain, Licentiate in Sciences, professor at the Bourbouze Laboratories. With a preface by H. Le Chatelier, member of the institute. 178 pages; 4½x7 inches; 78 illustrations. Published by Gauthier-Villars, Quai des Grande-Augustins, 55, Paris. Price, 3.25 francs.

M. Le Chatelier's sponsorship for this little volume must win for it respectful attention. It is intended as a handbook for practical men who have occasion to weld things autogenously, and is purposed to inform them upon the scientific principles of their work—not so much the deep underlying theories as the appliances and methods of operation. To describe the requisite dexterities of hand, however, is expressly disclaimed, for, as M. Le Chatelier remarks, these cannot be learned from a book, but only by practice under experienced masters. The author starts out with welding in general, brazing and autogenous welding, after which he describes the different forms of torches and preparation of different gases. Electric welding is given a chapter, while two, covering 50 pages, are accorded to aluminothermics and its applications. Autogenous welding is such a live subject that the volume should easily find its place. While the types of apparatus described are not bounded by national lines, the French are particularly in evidence here, and hence this book may perform a special function of informing us on Gallic progress in the new industrial art.

STEAM TABLES AND DIAGRAMS. By Marks and Davis. 106 6¼x9¼-inch pages; 8 illustrations in the text and two loose folded diagrams protected by a cover pocket. Longmans, Green & Co., New York and London. Price, $1, net.

The epoch-making discoveries of Reynault into the properties of steam are the foundation of the steam tables that have been in use until the immediate present. Present investigations, however, in both this country and Europe into the properties of saturated and superheated steam have superseded the work of pioneer investigators and new steam tables were needed. This need has been met by a recent edition of Peabody's tables and the work under review. Six tables are here presented occupying 62 pages. Table 1, saturated steam, temperature ranging from 1 to 689 degrees; Table 2, saturated steam, pressure ranging from 1 to 600 degrees; Table 3, saturated and superheated steam. This table is the longer part of the book, occupying 44 pages, the major column of which varies by even pounds pressure up to 250 pounds, then by 5 pounds up to 310 pounds, then by 10 pounds to 400, and by 50 pounds to 600. Table 4 is short, and gives the increase in total heat and in entropy for steam superheated for 600 to 2000 degrees. Table 5 gives boiling points for thermometer calibrations, and Table 6, thermal properties of water at saturation pressure for every 10 degrees for 20 to 670 degrees. Following are conversion tables, and a few tables of common logarithms and loge. The rest of the book discusses the data upon which the tables are based, outlines the studies of the authors and reasons for selecting the basic data that were used. There is also an explanation of the use of the two charts on the folded sheets which are a total heat-entropy chart for saturated and superheated steam and a total heat-pressure chart. We are glad to commend the work. It will prove valuable to anyone having to do with calculations involving the properties of steam.

Personals*

George W. Harman, formerly with the Frick Company, of Waynesboro, Penn., has become chief draftsman for H. B. Underwood, & Co., of Philadelphia.

Walter C. Allen, formerly general superintendent of the Yale & Towne Manufacturing Company's plant at Stamford, Conn., has recently been appointed general manager of that company, with headquarters in New York. Joseph A. Horne, formerly assistant general superintendent, has been appointed to fill the position of general superintendent left vacant by Mr. Allen's transfer.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

High-speed Drilling and Tapping Machine

The accompanying halftones illustrate a new high-speed drilling and tapping machine built by the Cincinnati Bickford Tool Company, Cincinnati, Ohio. This machine has been built both with gear-box and a variable-speed motor drive and is designed as a high-speed and high-power machine for the handling of high-speed twist drills, at the same time providing a slow speed for tapping with a quick return for withdrawing the taps. The machine is of heavy construction with increased strength in the table and table arm to withstand the heavy pressure due to high speed drilling and tapping. The bearing for the table on the arm is of large diameter and scraped to form a true bearing surface for the table. The head, which is vertically adjustable on the column, is counterbalanced, and the spindle, which is of high-carbon steel, is provided with ball bearing and jam nuts for adjustment and also has an automatic stop so that any number of holes may be drilled to a fixed depth. The positive-geared speed box located on the sliding head provides six rates of feed of respectively six, nine, thirteen, eighteen, twenty-seven and thirty-nine thousandths per revolution of spindle, any of which feeds can be used with any speed of the spindle. The friction back gear at the top of the machine can be left in continuous engagement although a handle is provided by which it may be disengaged if the operator desires to release it when it is not to be used. The lever for controlling the back gear is brought down on the left and near the front of the machine within convenient reach of the operator so that he can engage or disengage the back gear without stopping the machine. The same lever when set in a neutral position also furnishes a stop for the spindle.

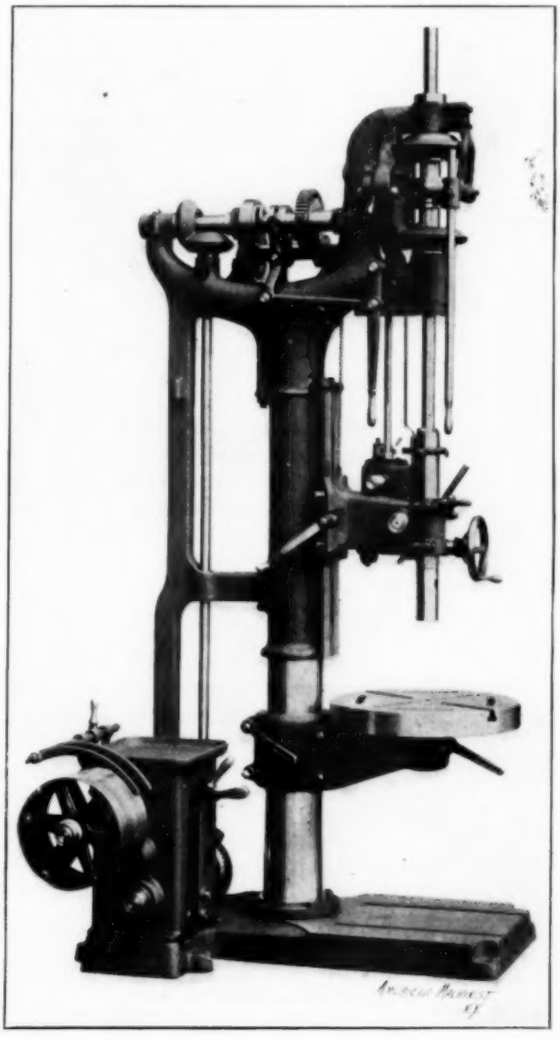


FIG. 1

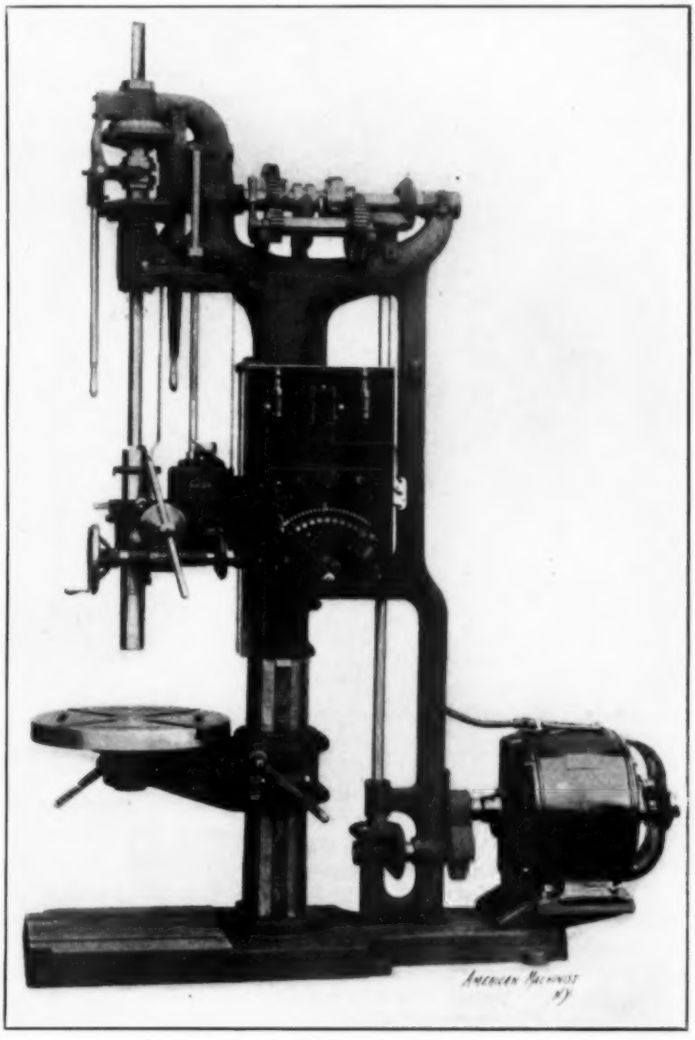


FIG. 2

HIGH-SPEED DRILLING AND TAPPING MACHINES

As illustrated in Fig. 1, the gear box is placed at the left of the machine so that the operator is able to make changes of speed without leaving his position at the front. Eight speeds are obtained with this gear box, and with the use of the back

gear at the top of the machine sixteen different spindle speeds are available. The gear box is of simple construction and carries at the top a convenient detachable tool tray.

The motor driven machine is arranged as shown in Fig. 2 with a motor mounted on the base and the controller with switch and fuses at the side of the column. It is arranged to give eighteen speeds which, in connection with the back gear at the top, gives a total of thirty-six spindle speeds. With either the motor or gear-box drive, correct spindle speeds for 70 feet per minute cutting speed are obtained for drilling, and a slow speed through the use of the back gears is obtained for tapping. When the tap has reached the desired depth the reverse is applied by means of the tapping-attachment lever, releasing the tap at the slow speed, after which it can be withdrawn four times as fast as when going forward. The geared tapping attachment is well known to our readers, as it has been used by this company for a number of years. The machine is supplied without this attachment when so required.

An index plate attached to the gear box indicates the position for the levers for different sizes of holes to be drilled or bored from ½ inch to 7 inches in diameter, and also indicates the number of revolutions at which the drill is driven when handling high-speed drills and cutters at 70 feet per minute cutting speed. The high-speed attachment made by this company for use in drilling small holes can also be applied. The machine is made in various sizes, from 24 to 42 inches, drilling respectively to the center of 25- to 43-inch work. When desired a square table with slots is supplied in place of the round table shown in the illustration.

12-inch Sensitive Drill

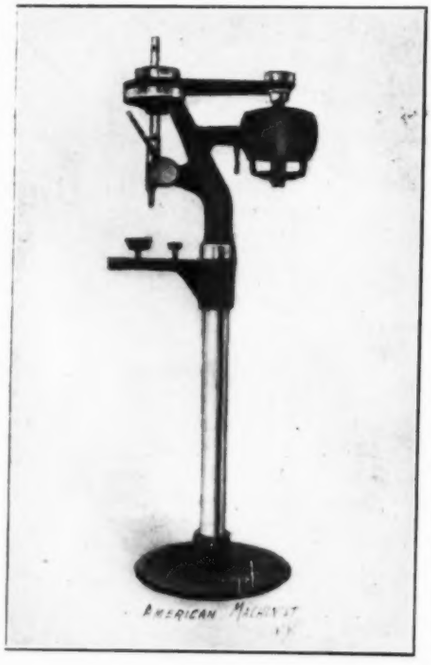
The accompanying halftones illustrate an improved form of the sensitive drill built by the Willey Machine Company, Jeffersonville, Ind. The machine as now built is heavier throughout. As will be noticed, the motor is connected to the spindle by a belt operating on cone pulleys, by means of which three changes of speed are obtained. The motor frame is adjustably mounted so as to permit of ready tightening of the belt. The starting switch is within the motor frame so that there are no connections outside of the motor. The table is square, is counterbalanced by a weight inside the column and can be swung around out of the way when desired. The drill operates to the center of 12-inch work and the greatest distance from the spindle to the table is 38 inches. The traverse of the spindle is 3 inches; the total hight of the drill, 67 inches.

Trade Opportunities in China

By M. de Moreira

China, which centuries ago was most progressive but stopped in its advancement, seems to have decided to resume the march of progress, and manufacturers all over the world are doing their utmost to push their products in this field, for so many years devoid of modern inventions.

The most profitable line of machinery of any kind just now, and the one which is most in demand is, without doubt, railway machinery and machine tools for railroad repair shops, etc. The great drawback, however, for American manufacturers is that the British have so much capital in China and control so much influence through banking and commercial houses that all the loans for railways are made though them and, through this influence, nearly always large amounts of the machinery needed are purchased in England.



12-INCH SENSITIVE DRILL

An Example of the Influence of the British

British capitalists, manufacturers, and commercial houses realize that the business of the future in China can best be secured by present efforts and that such efforts should be made right in the country itself in order to secure a foothold for the future. That they have succeeded in some instances is proved by the Kowloon-Canton railway. This railway is of very great interest to Americans, and here are facts that will explain more clearly the situation:

In 1843 the island of Hongkong was made a British crown colony; in the following years it became apparent that the acquisition of territory on the mainland, directly across the harbor, would be essential to the existence of the colony from a strategic point of view as well as for building sites, the island of Hongkong being very small and mountainous. In 1860 therefore, Great Britain demanded and obtained a perpetual lease of an area of four square miles of the peninsula of Kowloon and in 1898 a further grant of the mainland was brought under British jurisdiction on lease for 99 years. It happened, however, that during the same year the American-China Development Company obtained a concession for the construction of the Canton-Hankow railway, which, with the Peking-Hankow railway, when completed, will form a trunk line from Canton, the metropolis of south China to Peking the capital. The plan of the American company which had obtained the concession, included the development of a deep-water harbor in Chinese territory in the estuary leading to Canton. Should that plan become successful the commercial supremacy of the British would have been seriously menaced. To safeguard Hongkong's interests, prevent the development of such a port and at the same time obtain a share in the lucrative traffic that was anticipated, a concession was obtained by the British and Chinese corporation for the construction of a railway between Kowloon and Canton, where connection could be made with the line to Peking.

After having done a certain amount of work, the American-China Development Company gave up its concession for the Canton-Hankow railway and received the sum of $6,750,000 for the work it had done. This sum, which was to have been paid to it by the Chinese government, was furnished to China by the British in 1905.

The line is still under construction, the work being done naturally by the British, within the British leased territory, but some American machinery is used on the other Chinese part of the road.

I have given these facts to make manufacturers clearly see what they have lost through the power obtained by British capital, power which can be obtained just as well by Americans, if they have the foresight to see their opportunities.

A Promising Field for American Manufacturers

Where American manufacturers can certainly sell their machinery is to the Sunning railway, a competing line of the one just described. It will extend from a seacoast harbor known as Sam Kap Hoi, a point west of Hongkong and Macao, across the Sunning district to a connection with the Canton-Hankow railway's Samshui branch. From Sam Kap Hoi there will be built a connection to the Canton-Hankow railway, making this line therefore a competing one with the Kowloon-Canton.

The concession for the Canton-Macao railway has been canceled because of failure to fulfill certain conditions and the construction of this line will be by the Chinese end of the Canton-Hankow railway. These two lines ought to be fruitful of results for the American manufacturers.

Another reason why we have a very good opportunity in that section comes from the fact that the Chinese government has now supreme control of the Canton-Hankow railway. By imperial decree Chang Chih-tung, grand councillor and member of the grand secretariat, has been named to assume absolute control of the railway and to act in consultation with the viceroys and governors of the three provinces through which the road passes. He has full power to approve all purchases and since the construction of the line is far from being finished and the United States is considered as "a good friend of China," American manufacturers certainly are in conditions to have American machinery purchased by the road which should have been an American enterprise.

The Manchurian Field

The province of Manchuria, from the point of view of railways, is also very important to manufacturers. In the north two lines; the Kuangchengtsu-Kirin and the Hsinmintun-Mukden on the Chinese and Japanese Manchurian division are to be constructed and improved and machinery of different kinds is needed, especially machine tools for the repair and construction shops. The road starts from the north wall of Changchun, passes to the south of Shihlipu, Matoushan and Chuanyuanhou. In the neighborhood of the Tashui river it crosses the main road at a right angle and proceeds toward the north to the gate of Kirin city. This railway is to be 75 miles in length and will cost seven millions of dollars. The construction of the line has just begun, and, a point very important to manufacturers, very few purchases have been made so far.

In the south of Manchuria, still more signs of progress are shown in the standardizing and the development of the railways. The South Manchuria railway has already purchased some American rolling stock, the old stock being turned over to the Japanese from whom it was taken during the war. The whole line will be of standard gage, and though machinery for the work on the road has not been purchased, the railway authorities are in favor of machinery of American make and our manufacturers can easily obtain large orders from the railroad. This company possesses also, electrical plants, and a steamship, thus furnishing opportunities for manufacturers of other kinds of machinery.

Competition, as I have said already, is very keen in China and the British and Germans use every possible means to further their commerce. Americans should do the same. The railway construction between Tientsin and Pukow has just been started and the money furnished for its construction comes from a British and German syndicate. What more natural that in a case like this, the machinery, implements and rolling stock should be purchased from these two countries?

Another railway which is to be constructed is the Chefoo-Weinsien railway which has been planned by the Chefoo merchants to regain for that port trade which the Shantung railway has diverted to the port of Tsingtau. The Fuhkien railway, which will connect this province with the province of Kwang Tung, is also under construction. Though the rails have been ordered from works in China, the machinery will be all foreign; the bridges having been ordered from this country.

All this movement in China in regard to railways proves beyond argument that China has entered upon an era of progress, and anyone knowing the character of the Chinese knows that since they have started on the road of progress they will not stop there but on the contrary will push on and probably in a short time surpass their neighbors in Japan. To that effect and realizing the importance of building their own railways without the help of the foreigner, the Ministry of Post and Communications has decided to open a railway college and admit a number of students to be trained for three years, after which period they will be sent to various foreign countries to pursue further studies in railway engineering. This step is most significant of China's desire to succeed in her railway undertakings.

Cutting a 77 Tooth Gear

By Wesley Emery McArdell

The other day a job came into the shop which seemingly presented no unwonted difficulties; just an eight-pitch gear with seventy-seven teeth. The only apparent thing out of the ordinary was that the blank was to be turned an eighth of an inch smaller in diameter before cutting so as to replace a gear having a smaller number of teeth.

So a tag was put on the blank and downstairs it went, only to come up again in a few moments with a message from the shop foreman stating that he could not cut it. He said it was impossible to cut any odd number of teeth above sixty-one owing to the fact that our largest circle on the dividing head was sixty-five.

The "super" put on his thinking cap; the boss took out his pad and pencil, but neither one could seem to arrive at any other solution than forty holes on the seventy-seven circle. Clearly we were up against it and everybody interested adjourned to the milling machine, with the faint hope perhaps, that some one would get an inspiration that would save the day. Of course we could send the job back, and admit we were stumped, but that didn't happen to be the general order of things in the shop; and everyone felt it was "cut it or bust."

A list of the number of holes in each circle was taken and "the powers that be" retired to the office. Each cudgeled his brains to find a way out of the difficulty. Work was none too pressing in the office and this bit of calculation was just a pleasure, incidentally affording the office staff a good chance to "show 'em what's what down in the shop." The foreman, a man of wide experience, relied more on his men than on the office and so he passed out the problem to some of the boys at the benches, and incidentally he cut the first tooth.

Among several suggestions, the most plausible one was to set up for one hundred and fifty-four teeth and cut every other one, which looked good until it was found that this number called for twenty holes on the seventy-seven circle.

Finally one of the younger men, of a mathematical trend of mind, proposed the following plan: "Set up for eleven teeth, cut them; then set up for seven teeth, start to cut from the first tooth cut when the dividing head was set up for eleven teeth and cut six teeth distributed around the circumference. Continue cutting with the head set up for seven, starting each time from the second, third, fourth, etc., tooth cut at the first operation."

The idea looked good and without any more delay the job was started. The first tooth, the seventh, fourteenth, etc., were cut, eleven in all. Locking the dividing head with the cutter in the first tooth space cut, the dial was shifted so as to cut seven teeth. Six teeth were cut around the circumference and after shifting the blank so that the second tooth was the starting point, we repeated cutting around.

Presently two teeth appeared side by side, and then three and, in not much more time than would have ordinarily been consumed, the gear was completed.

This method is not applicable to all large odd numbers, but it does apply to a considerable number of gears, not otherwise possible to cut in a small shop having limited facilities. Thus to cut a ninety-nine-tooth gear, set up for eleven teeth and then for nine; setting up for thirty-three and three, respectively, would not do.

Boiled down, the rule is: Factor the number and select two of the largest factors having no common divisor; set up first for one, and then for the other.

"Estimating by Phone"

By Terry

This incident occurred in a shop still in existence on the Clyde. The firm was in charge of the sons of the founders, as "Old Sandy," the only one left, was supposed to be retired, but he thought otherwise, and still visited the shop for the sole reasons that he thought they could not get along without him, and at the same time express his opinion on the silly things the boys were doing, and how little they knew about making engines.

"Fancy having a lot of men in an office to make pictures and a lot of figures before they can start to make an engine, when I can start the patternmakers right away, with a wee bit-o'-chalk."

Regarding the new telephones with displeasure, Old Sandy said: "Fancy pitting them wee tinkling things on the wa', jist weemin's playthings."

Finally came his last visit to the shop. He sent down for "Jeemie," the foreman smith.

"I've a wee bit sketch for ye, to tak' a look at, Jeemie. It's for some roofing for McAdam."

"Ting-a-ling."

"Och! never heed that wee bit thing on the wa'. There's this lot of tie rods."

"Ting-a-ling."

"I expect ye'll be hevin' one of them by-and-by, Jeemie, jist to tell you—"

"Ting-a-ling."

"who owns the shop."

"Ting-a-ling-ling."

"Jist look ower it, Jeemie, while I give this thing on the wa' a shake."

Old Sandy went over to the 'phone and shook every part of it that would shake, and felt satisfied that it would not interrupt again.

"Now, Jeemie, we'll maybe get peace to finish this wee bit job. Dee ye think you could finish it by the fair,"

"Ting-a-ling—Ting-a-ling." Sandy was now in a rage, and opening the counting-house door demanded a clerk to "Come awa' here, an' speak to this bell on the wa'." A clerk came over.

"Hello!" "Yes, sir, it arrived this morning and we'll ring you up and give a price as soon as possible after Mr. John comes in."

The estimating now proceeded at a rapid rate for a few minutes, but Jeemie kept one eye on the "wee bit bell on the wa'," as he knew if that spoke again, he would feel more comfortable in the smithy.

"You'll hev' these angles in stock, Jeemie?"

"Ting-a-ling—Ting-a-ling."

Old Sandy made for the counting house and the clerk who had spoken to the bell.

"You confounded ninny, whit wey canna ye dee as you're telt? Awa' out of this and never pit foot in the place again while I'm living. Ye'll get your wages from Mr. McNale, an' I dinna want any impidence. Awa' doon, Jeemie, an' ca' up your man with his hammer."

Just then Mr. John arrived, but all attempts to pacify Old Sandy failed, and he went out into the street and in a very few days he had "crossed the bourne" to where we hope there are no wee bit "bells on the wa'." "Old Jeemie" is still in the smithy and when he tells this story always adds this sequel, "That last 'Ting-a-ling' was a call from the McAdams to say the firm was not to trouble about sending a price, but get ahead with the work at once. I wonder if Old Sandy knows?"

Forthcoming Meetings

International Association for Testing Materials, fifth congress, Copenhagen, Denmark, September 7-11.

National Machine Tool Builders' Association, fall meeting, October 12 and 13, New York City. P. E. Montanus, secretary, Springfield, Ohio.

Business Opportunities

Otto Davis will establish a button factory at Iowa City, Iowa.

The Antigo (Wis.) Confectionery Company Till enlarge plant.

The Marks Shingle Mill, Menominee, Mich., was destroyed by fire.

The U. S. Gypsum Company, Superior, Wis., will rebuild its plant.

The Montana Mattress Company, Butte, Mont., will build a new factory.

The Hotel Strand, Atlantic City, N. J., will enlarge its power plant.

The Hotel Savoy, Atlantic City, N. J., is to enlarge its power plant.

The Oakland Motor Car Company will enlarge its plant at Pontiac, Mich.

The Paine Lumber Company, Oshkosh, Wis., will rebuild its planing mill.

The Michigan Elm Hoop Company, Marinette, Wis., will build a stove plant

Chas. Wissmath & Sons, Fort Madison, Iowa, will enlarge its packing plant.

The Halstad Milling Company, Hettinger, N. D., is erecting a new flour mill.

The Russell Miller Milling Company will erect a flour mill at Billings, Mont.

The Mason Auto Company, of Des Moines, Iowa, will build plant at Waterloo.

The Burlington (Iowa) Basket Company will rebuild its plant, recently burned.

The Columbus (Ohio) Bolt Company is preparing to erect a new factory building.

The Richmond (Va.) plant of the American Locomotive Company is to be enlarged.

The mill of the Freeman Lumber Company, at Engadine, Mich., was destroyed by fire.

The East Jordan Lumber Company, East Jordan, Mich., will build a machine shop.

F. R. Patch & Co., Rutland, Vt., builders of stone machinery, are building an addition.

The International Lumber Company, International Falls, Minn., will erect a new mill.

The Heald Machine Company, Worcester, Mass., will build an addition to its boiler house.

The upholstering plant of the W. C. Russell Company, Beaver Dam, Wis., was partly burned.

The Cleveland (Ohio) Machine and Manufacturing Company will erect a two-story addition.

The Wilbraham-Green Blower Company, Pottstown, Penn., will build an addition to its plant.

The Bay City Forge Company, whose plant at Erie, Penn., was recently burned, will rebuild at once.

The Antrim Iron Company, Mancelona, Mich., is erecting a new mill to replace one recently burned.

R. Williamson & Co., Chicago, Ill., manufacturing gas fixtures, are erecting a new six-story factory.

The Otsego (Mich.) Coated Paper Company will build an addition to plant doubling its capacity.

M. Gould's Son & Co., Newark, N. J., manufacturers of brass goods, will build a four-story addition.

The roller mill of G. G. Maddy and J. W. Peary, at Pleasantville, Iowa, was burned. Loss, $15,000.

The plant of the Menominee River Shingle Company, Menominee, Mich., was burned. Loss $30,000.

Gorhman Bros., Mt. Plesant, Mich., have built a new engine room and are installing new equipment.

The Lansing (Mich.) Pure Ice Company will increase its capacity and put in a new engine and boiler.

The Amalgamated Sugar Company, of Ogden, Utah, is considering the location of a plant in Harlem, Mont.

Plans have been prepared for a factory building for the manufacture of boxes for William Grassley, Portland, Ore.

The plant of the Red Oak (Iowa) Electric Light and Heat Company was wrecked by the explosion of a flywheel.

The New York & New Jersey Canning Company will build a $50,000 canning factory at Dickinson, N. D.

The Robin Hood Ammunition Company, Swanton, Vt., is making plans for erecting a new and up-to-date plant.

The Bingham Company, manufacturer of photographic supplies, Binghamton, N. Y., is erecting a new factory

The Henry Engineering Company, 116 27th street, South Brooklyn, N. Y., contemplate installing a 12-ton hammer.

The Massillon (Ohio) Rolling Mill Company has let contracts for additions to its plant. Five new sheet mills will be installed.

The Lackawanna Railroad Company is building a new roundhouse at Hampton, Penn., which, it is said, will cost over $1,000,000.

The Glasscock Manufacturing Company, Muncie, Ind., will erect an addition to be used for manufacturing automobile bodies.

Contractors are estimating on the construction of a large new leather plant for J. H. Ladew & Co., of New York, at Newark, N. J.

Plans for the enlargement of the Pittsburg plant of the American Locomotive Company in Woods Run have been completed.

The capacity of the power plant of the Owensboro (Ky.) City Railway Company is to be increased. I. C. Ray, general manager.

Plans for the construction of a new roundhouse for the Evansville & Terre Haute Railroad at Evansville, Ind., are being prepared.

The Constantine Manufacturing Company, Madison, Wis., making children's vehicles, etc., contemplates the erection of a factory.

Philip Keefer, Nanticoke, Penn., expects to soon replace his present steam boiler and engine either with a gas engine or electric motor.

The Merrimack Manufacturing Company, Lowell, Mass., has taken out permit for the erection of an addition to the engine room.

The Hupp Turner Company, Detroit, Mich

a new concern engaged in manufacturing automobile parts, is installing new equipment.

The Chadwick Engineering Company, Pottstown, Penn., is increasing the capacity of its plant and will install additional equipment.

Frank Swanstrom, Duluth, Minn., now conducting a blacksmith shop, will remodel building for the manufacture of buggies and wagons.

The Fellows Gear Shaper Company, Springfield, Vt., has completed plans for a new addition to be used for pattern and machine rooms.

The Electrical Products Company is to erect a large plant in Chippewa, Ontario, for the manufacture of steel rails and other products.

The Wheeling Metal and Manufacturing Company, Wheeling, W. Va., which was recently destroyed by fire, is erecting a temporary plant.

The Crescent Automobile Company, Jersey City, N. J., is to occupy large new quarters to be three stories high with machine shop attached.

The Aguilar Coal Mining Company, Aguilar, Colo., is to erect a new structure requiring new haulage engines as well as tramway supplies.

Bradford & Lasher, Bloomington, Vt., are fitting up a new machine shop and installing tools for the manufacture of knitting machinery.

The Dean & Barry Paint Manufacturing Company, Columbus, Ohio, is erecting an addition to its present plant to cost about $25,000.

The Soo railroad shops at North Fond du Lac, Wis., are not to be moved, as reported, but are to be added to by the erection of another building.

William Haas, of Cairo, Ill., has purchased a site in Sherman, Tex., on which he will erect a factory for the manufacture of handles for hoes, axes, etc.

The National Tube Company, McKeesport, Penn., is replacing one of its old buildings with a modern structure to be equipped with new machinery.

Fred Miller, Monroe, Wis., formerly with the Miller Manufacturing Company, will engage in the manufacture of a metal punch and shearing machine.

The Brooks Bank Note Company, Springfield, Mass., is to build a large addition to its present plant which will be equipped with new machinery.

The Pines Manufacturing Company's plant, Gardner, Mass., was considerably damaged by fire. Time-recording clocks is one of the products manufactured.

The Peidmont Mills Company, High Point, N. C., a new concern, will erect a plant for the manufacture of hosiery. J. H. Adams and J. H. Mills are the promoters.

The West Hosiery Company, Plymouth, Penn., will install new machinery in its machine shop department and make changes in its electric drive equipment.

The plant of the Zeeland (Mich.) Cheese and Butter Company has been acquired by the Phoenix Cheese Company, of New York. New machinery will be added.

The Berbecker & Rowland Manufacturing Company, Waterville, Conn., manufacturer of brass specialties, is planning for the erection of two new factory buildings.

The Harrisburg Iron and Steel Company, Harrisburg, Penn., formerly the United Iron and Steel Company, contemplates adding a machine shop to its plant.

The Puget Sound Iron and Steel Works, Tacoma, Wash., has commenced work on four large structures, including a machine shop, a forge shop and a foundry.

The A. P. Smith Manufacturing Company, East Orange, N. J., will erect six new factory buildings for the manufacture of pipe fittings and brass water-works fixtures.

The Corrigan-McKinney Company, Cleveland, Ohio, has awarded a contract for the construction of several buildings, including a machine shop, engine room, powerhouse and pumping house.

The Nova Scotia Technical College, Halifax, N. S., will require equipment for small power plant and mechanical and electrical laboratories. This college requests advertising literature for its files and class reference.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to September 27 for cast-steel tumblers, chain, plow-steel wire, ammonia indicators, forge blowers, cutter engine, traveling crane, jet pumps, etc., as per Circular No. 536.

The Howard Motor Car Company is to be moved to Athens, Penn., and the concern will be changed to the Athens Auto Truck Company, and will manufacture power drays, trucks and delivery wagons, in addition to their two designs of automobiles.

The Isthmian Canal Commission, Washington D. C., will receive bids up to 10:30 a.m., September 8, for pipe and fittings, valves, steam traps, packing, washers, pulleys, hammers, rivets, screws, tacks, flue cleaners, reamers, bits, twist drills, wrenches, oil cups, steel tapes, etc., as per Circular No. 535.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: September 14—Milling machine (schedule 1647), hacksaw blades, twist drills, reamers, (schedule 1631), bolts and nuts, rivets, staples, wrenches (schedule 1649), electric drills (schedule 1647), metal lockers (schedule 1635), rolled bronze, steel beams (schedule 1633), bar iron, plate steel, steel angles (schedule 1648), copper, galvanized iron, wrought iron pipe, brass valves (schedule 1650).

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: September, leather belting, valves (schedule 1582), drills, marine screws, wrenches (schedule 1580), water meter (schedule 1578), sulphur burner (schedule 1606), motor borer (schedule 1607), gasolene engine (schedule 1609), intensifier (schedule 1606), propelling machinery for launch (schedule 1608), motor driven panel raiser (schedule 1607). September 21—Chain, pneumatic hose (schedule 1611), motor-driven pump (schedule 1587), steam pump (schedule 1588), scales and weights (schedule 1622), motor-driven compressor (schedule 1612), turret-turning equipment (schedule 1612).

New Incorporations

West Point Panel Company, West Point, Va Manufacture articles of wood. Capital, $50,000. H. E. Topping, president.

The National Coning Machinery and Bottling Company, Calumet, Mich. Capital, $400,000. Will manufacture paper bottles.

Aluminum Casting Company of New Jersey, East Orange, N. J. Capital, $20,000. Incorporators, G. H. Kelly, J. C. Rexroth, B. E. Robertson.

Commercial Rubber Company, Chicago, Ill. Capital, $25,000. Incorporators, W. Holmes, E. J. McGinnes, T. H. McCoy. Will manufacture rubber goods.

Newall Manufacturing Company, Chicago, Ill. Manufacture tools and metal articles. Capital, $25,000. Incorporators, G. W. Careton, E. D. Clapp, W. J. Fanth.

Simplex Metal Bound Box Company, Paterson, N. J. Manufacture metal boxes. Capital, $10,000. Incorporators, T. S. Edwards, E. E. Flora, F. W. Rothermill.

Mohawk Foundry Company, Schenectady, N. Y. Manufacture iron, steel, etc. Capital, $25,000. Incorporators, A. F. Shaffer, A. F. Hallbauer, M. V. Hoffman.

Garland Automobile Company, New York, manufacture automobiles and motors. Capital, $25,000. Incorporators, G. W. Garland, Jr.; G. P. Strobel, J. A. Garland.

Hill-Tripp Pump Company, Anderson, Ind., manufacture and sell pumps. Capital, $30,000. Directors, A. E. Tripp, Hugh Hill, Forrest Hill, H. C. Stilwell, T. M. Stilwell.

The Elizabeth Taxicab Company, Elizabeth, N. J. Capital, $100,000. Incorporators, F. N. Voorhees, W. H. Cole, F. V. Price, Jr. Will manufacture automobiles, etc.

Robert Ewing & Sons, Centre Island, Albany county, N. Y. Manufacture laundry machinery. Capital, $30,000. Incorporators, R. Ewing, C. E. Ewing, H. E. Ewing, Troy.

Ivory Button Manufacturing Company, Seneca Falls, N. Y. Manufacture buttons, etc. Capital, $150,000. Incorporators, Henry Stowell, J. S. Gay, J. W. Gallagher.

Gray Adding and Listing Machine Company, Rahway, N. J. Capital, $200,000. Incorporators, D. C. Gray, J. B. Furber, W. A. Ransom, Will manufacture typewriters, etc.

James B. Davie Foundry Company, Brooklyn, N. Y. Foundry and metal working. Capital, $20,000. Incorporators, J. B. Davie, Brooklyn; W. Davie, J. Davie, Jr., New York.

Flemington Garage Company, Flemington, N. J., to operate and maintain automobile garages. Capital, $25,000. Incorporators, J. R. Hall, H. J. Rodenhaugh, J. G. Lawshe.

Chicago Automobile Self-starting Appliance Company, Chicago, Ill. Manufacture automobiles and appliances. Capital, $70,000. Incorporators, C. E. Crane, H. Hobbs, C. Conlon.

Philadelphia Art Metal Company, Camden, N. J. Capital, $50,000. Incorporators, David M. Patton, Jacob J. Staley, Albert W. Staley, Will make metal novelties and specialties of all kinds.

Burroughs Remountable Rim Company, New York, will manufacture wheels, tires and rims for automobiles, etc. Capital, $200,000. Incorporators, F. L. C. Keating, J. Palmer, M. Rosett.

Simplex Filing Device Company, Buffalo, N. Y. Manufacture filing devices, cabinets, etc. Capital, $125,000. Incorporators, Chas. V. Smith, Toronto; E. Van Den Voner, F. B. Hartzell, Buffalo.

Mumford Manufacturing and Supply Company, New York. Manufacture belt lacing devices, tools, electrical machinery, etc. Capital, $25,000. Incorporators, F. A. Schulz, A. R. Costigane, F. C. Wilde.

The Typewriter Remanufacturing Company, Great River, N. Y., manufacture, rebuild and repair typewriters, etc. Capital, $500,000. Incorporators, F. T. Pace, H. I. Sherwood, W. Huck, Jr., New York City.

The Alpha Bottling Machine Company, Dover, Del. Capital, $100,000. Incorporators, John H. Cartwright, John Ramsey, Geo. D. Benham, of Philadelphia. Will manufacture bottling machine and bottle washer.

N. Y. Self-winding Electric Clock Company, New York. Manufacture electric self-winding clocks, batteries, etc. Capital, $50,000. Incorporators, S. W. Livingston, H. A. St. George, C. R. Frazier, all of No. 41 Park Row, New York.

The Van Neu Manufacturing Company, New York. Capital, $100,000. Incorporators, W. S. Van Horn, E. Neumann, A. Neumann, Jersey City, N. J.; T. A. Hill, Brooklyn, N. Y. Will manufacture mechanical tools, particularly typewriters.

The Jeffries Coal and Iron Company has been incorporated at Dover, Del., to manufacture iron and steel and other metal products and devices. Capital, $10,000. Incorporators, F. R. Hansel, Geo. H. B. Martin and S. C. Seymour, all of Philadelphia.

New Catalogs

Nutter & Barnes Company, 326 A street, Boston, Mass. Catalog No. 14, describing metal saw cutting-off machines and automatic saw sharpeners. Illustrated, 20 pages, 6x9 inches, paper.

The Cleveland Punch and Shear Works Company, Cleveland, Ohio. Hand Book and Stock List of power punches, shears, bending rolls radial drills, punches, dies, etc. Illustrated, 56 pages, 4½x7 inches, paper.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E.G.Smith, Columbia,Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—To purchase drawings of a really first-class back knife gauge lathe. Offers to Box 572, AMERICAN MACHINIST.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Dies designed, all kinds, with cost of making; practical working drawings; send sketch of model. Box 548, AMERICAN MACHINIST.

Manufacturers considering active representation in Philadelphia territory. Address "Mechanical Engineer," AMER. MACHINIST.

We design and build light machinery, including fixtures, jigs, tools, punches and dies, and model work. The Matson Machine Co., Bethel, Vermont.

Special machines for reducing the cost of production designed; inventions developed to a practical and commercial basis. Benj. Brownstein, mechanical engineer, Trenton, N. J.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

By manufacturer, agents or dealers to handle oil cup of improved design; excellent cup and can be sold at a low price; large field for the sale of this device among machine shops, mills, etc. For particulars address Box 612, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—By a first-class machinist with some tool-room experience, a chance to become more proficient in jig and fixture work, or punch and die work. Box 637, AM. MA.

Wanted—Position as superintendent, assistant or general foreman, thoroughly conversant with modern up-to-date methods in tool design and manufacturing small or medium interchangeable work; executive ability; can produce results, quality and quantity at minimum costs; at present employed in responsible position. Box 591, AMERICAN MACHINIST.

ILLINOIS

General foreman for drop-forge plant, wide experience, desires change. Box 624, AM. MA.

INDIANA

Superintendent of forge shop on shape or drop hammer work; costs and weights from drawings; contract preferred; 20 years' experience. Box 569, AMERICAN MACHINIST.

MASSACHUSETTS

Superintendent, wide experience in manufacturing, desires change. Box 525, AM. MA.

Designer and checker, at present employed; technical graduate; specialty; centrifugal and reciprocating pumps and pumping engines; wishes other position. Box 642, AM. MACH.

Chief draftsman and practical designer; technical graduate; seven years' experience on steam engines and electrical machinery in general; desires permanent position. Box 632, AMERICAN MACHINIST.

Wanted—A position as superintendent, who has had a large experience in the manufacture of plumbers' supplies and sanitary specialties and general brass goods manufacturing; can handle help and produce the goods; not particular as to location. Box 635, AM. M.

A mechanical superintendent and production engineer of practical experience, successful in increasing production and reducing cost of manufaturing; good organizer, energetic; can obtain highest quality and quantity of work from employees; invites correspondence from parties requiring competent men; single, and location immaterial. Box 634, AM. MA.

MICHIGAN

Mechanical engineer with 12 years' experience in manufacture of machine tools, seeks position as salesman. Box 631, AMER. MACH.

Designer with 12 years' experience in machine tool manufacture seeks responsible position; eight years in charge of work; 30 years of age. Box 630, AMER. MACHINIST.

Mechanical engineer, technical graduate, energetic, aggressive and systematic, 16 years' experience as designer, chief draftsman and engineer; conversant with both mechanical and structural work. Desires responsible engineering position with first-class firm. Box 586, AMERICAN MACHINIST.

MINNESOTA

Responsible position in the manufacture of gas engines and suction producers by designing engineer and expert. Sixteen years' experience; highest references. Box 639, AM. M.

NEW JERSEY

Position wanted by technical graduate with experience on general automatic machinery and printing-press design. Box 608, AM. MA.

Mechanical engineer, 28, first-class designer and draftsman of thorough shop experience, desires responsible position; now employed. Box 604, AMERICAN MACHINIST.

NEW YORK

Draftsman, experienced, seeks position. Box 584, AMERICAN MACHINIST.

Experienced superintendent open to engagement this fall; good reliable mechanic and executive; diligent, aggressive, up-to-date. Box 599, AMERICAN MACHINIST.

By a mechanic of 20 years' experience, a position as foreman of department engaged in building special machinery; New York State preferred. Box 644, AMER. MACH.

Technical graduate, married, open for engagement; twelve years' experience engineer and superintendent, electric and hoisting machinery; best of references. Box 622, AM. MA.

Wanted—Position as assistant superintendent; present position chief draftsman, fast steam engines, pumps, condensers and general machinery; best references. Box 623, AMERICAN MACHINIST.

Foreman of machine shop desires change; am an American, age 30, married; 14 years' experience as machinist, toolmaker, draftsman and foreman; technical education; interview if desired. Box 641, AMER. MACH.

OHIO

Mechanical engineer (30), University graduate, nine years' shop and drawing-room experience, desires a position as assistant engineer or chief draftsman; at present employed by large concern on crane design; A-1 designer and up-to-date; hoisting machinery preferred. Box 628, AMERICAN MACHINIST.

PENNSYLVANIA

Progressive young pattern shop foreman wants position; experienced in pattern shop costs and systematizing. Box 593, AM. MA.

Cost accountant, thoroughly experienced in the installation of modern cost and storeroom systems, desires change. Box 602, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—A first-class toolmaker on jig and fixture work. Box 621, AMER. MACHINIST.

ILLINOIS

Draftsman wanted for jigs, tools and general automobile work. Buda Foundry & Mfg. Co., Harvey, Ill.

Wanted—First-class operator for 18-inch Landis plain grinding machine. Otis Elevator Co., 15th and Laflin Sts., Chicago, Ill.

Wanted—A designer, technically educated and experienced in intricate automatic machinery. In reply give references and full account of training and experience. Box 627, AMERICAN MACHINIST.

Wanted—Factory superintendent in a.c. motor line. Must be able to produce first quality goods at minimum cost. Systematic, energetic man necessary for growing position. Advise as to qualifications and salary. Box 575, AMERICAN MACHINIST.

INDIANA

Wanted—Draftsmen for gas works machinery. State experience, age and salary expected. Chief Draftsman, The Western Gas Construction Co., Fort Wayne, Ind.

Two experienced foremen for machine and assembling rooms, manufacturing gasolene motors. Give reference, experience and age. Box 262, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—First-class draftsman. Supervisor of Drafting Rooms, General Electric Co., Pittsfield, Mass.

Wanted—Foreman to take charge of brass machining department, employing 30 men on line of work similar to valves. Box 619, AMERICAN MACHINIST.

Brass foundry foreman; high-grade, competent man take charge of brass foundry, melting about 300,000 pounds per month, producing valve, pump and engine parts, including large bronze pump cylinders. Box 618, AM. M.

Wanted—First-class valve salesman for Boston and immediate vicinity. State where last employed. Good opportunity for energetic and ambitious man. All communications strictly confidential. Address: The Fairbanks Company, Boston, Mass.

Wanted—Thoroughly competent young man with some mechanical and executive experience to act as assistant superintendent in a small thoroughly equipped progressive factory manufacturing small tools, located in a large city in Western New England. Owing to certain conditions right man has an unusual opportunity for speedy advancement. In sending application state fully in detail all qualifications, for whom you have worked, present position, salary expected, etc. Box 638, AMERICAN MACHINIST.

MICHIGAN

Wanted—A few first-class toolmakers on small work; good wages and steady employment for competent men. Box 278, AM. MA.

Wanted—First-class milling machine and lathe hands; give age, experience and wages expected. Apply Buick Motor Co., Flint, Mich.

Wanted—First-class man to take charge of tool crib; state age, experience and wages expected. Apply Buick Motor Co., Flint, Mich.

Wanted—25 first-class monitor hands and 12 assemblers. Apply by letter to "Superintendent," Detroit Lubricator Co., Detroit, U. S. A.

Wanted—Electrical engineer for drafting room, familiar with telephone and electrical machine design. Good salary to right man. Ford Motor Company, Detroit, Mich.

Wanted—By a large company, a man who is fully capable of designing A-1 tool equipments for turret lathes, such as Gisholts and similar machines, of which we have a large number. Applicant must be well posted on most effective methods of procuring results from turret lathes, and able to put his ideas to effective use; work will be steady and pay liberal to the right man; state qualifications fully. Box 625, AMERICAN MACHINIST.

MINNESOTA

Wanted—Tool and metal patternmaker, familiar with the making of dies for pressed steel work in agricultural implement plant. Monitor Drill Co., Minneapolis, Minn.

MISSOURI

Wanted—Two all-round machinists (lathe hands preferred), and also one first-class milling machine hand on job work; steady work and good wages to the right man; open shop. Hugh Mathews, Kansas City, Mo.

NEW JERSEY

Wanted—Tool room foreman who thoroughly understands die work and building of special machinery and is capable of estimating costs; state age, experience and salary expected; A-1 references required. Box 620, AMERICAN MACHINIST.

NEW YORK

Wanted—Only first-class toolmakers on die and jig work. Bundy Manufacturing Co., Endicott, N. Y.

Wanted—Mechanical draftsmen, experienced in electric traveling crane designing. Box 633, AMERICAN MACHINIST.

Tool Designer Wanted—A-1 man on light interchangeable work for central New York. State experience and salary desired. Box 581, AMERICAN MACHINIST.

Toolmakers wanted; first-class men experienced on jigs, fixtures and fine gages for close small work. State age, experience in detail, and wages expected. Remington Arms Company, Ilion, N. Y.

Designing engineer, competent to develop our line of punch presses and machinery for sheet metals; wide experience in this special field absolutely necessary; liberal compensation to the right man. Applicants please state experience, etc. Niagara Machine and Tool Works, Buffalo, N. Y.

Lathe, planer and boring mill hands wanted for day and night shift; no labor troubles, increasing force; applicants must state wages desired, past experience, if employed at present, and the names of past employers, to receive further consideration. Application considered confidentially. Apply Ingersoll-Rand Co., Painted Post, N. Y.

Wanted—High-class factory superintendent to take charge of plant employing 750 hands; eight acres of floor space, 1800 machines; plant includes machine shop and tool room for manufacturing all tools and machinery in use; none but first-class men need apply; one with technical education preferred. Box 640, AMERICAN MACHINIST.

Wanted—First-class machinists and toolmakers; open shop, nine hours per day, six days per week; all new modern tools; no labor troubles; plenty of work on hand; clean, healthful, up-to-date city in which to live; highest wages paid to workmen who can demonstrate their ability to be rated as first-class machinists. Apply stating experience, references and wages required. Box 629, AMERICAN MACHINIST.

Wanted—A thoroughly practical and energetic mechanic to take a position as rate fixer on premium work in the shop, building high-speed engines; must be familiar with jigging work and fixtures; must have fair education, good at figures and systematic; must be able to go into machine shop and make demonstrations. Apply stating age, nationality and previous experience, also whether employed at present and by whom. Answers will be treated confidentially. Box 643, AMERICAN MACHINIST.

OHIO

Machinist. 201 Nicholas Bldg., Toledo, O.

Machinists—Lathe, boring mill and vise hands, thoroughly experienced. Address The Bullock Electric Mfg. Co., East Norwood, O.

Several first-class draftsmen with experience on crane and heavy machine work; state age, experience and salary expected. Box 590, AMERICAN MACHINIST.

Wanted—Toolmaker experienced on small accurate work and sewing machine experimenting; give age, experience and wages expected; our normal day is nine hours. Box 626, AMERICAN MACHINIST.

Wanted—Foreman erector familiar with gas engine work. Also erecting engineer, crank lathe man, boring mill man, Jones & Lamson operator and toolmaker. Steady work, best wages. Box 571, AMERICAN MACHINIST.

Machinists—We are increasing our output, and invite application from machinists with experience on lathes, turret lathes, boring mills, milling machines, screw machines, etc. State full experience and wages. Foos Gas Engine Co., Springfield, Ohio.

Wanted—A superintendent in a machine shop employing 100 men and manufacturing heavy pressure hydraulic machinery; he must be high-class, systematic, energetic and a thorough executive; state past experience and present position; no inquiries will be made of present employer unless authorized by applicant. Address Box 601, AMER. MACH.

Wanted—Immediately, by a large company building high grade machine tools, a salesman. Mere order takers not considered. Preference given to a young man with ability who has had technical training and practical experience. Applicant should give full particulars about himself so as to enable us to judge of his fitness. Only reliable, ambitious men, looking for a permanent position with exceptional opportunities for advancement need apply. Letters of applicants will be treated strictly confidential. Box 574, AM. M.

PENNSYLVANIA

Machinists wanted. Lathe, boring mill and floor hands, air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Designer and draftsman on general machinery. A first-class designer capable of taking charge of work. Also one draftsman wanted. Box 447, AMERICAN MACHINIST.

Wanted—A modelmaker on typewriter and adding mechanism. Must be thoroughly competent, and experienced on small interchangeable work. Box 589, AMERICAN MACHINIST.

Wanted—General superintendent. A man with wide experience and up-to-date methods in general machine shop and foundry practice, to take charge of a shop employing about five hundred men, engaged in the building of heavy machinery. All correspondence will be treated strictly confidential. In writing give references, experience and age. Box 464, AMERICAN MACHINIST.

Wanted—A good live agent in every shop or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Klenzola Co., Erie, Pa.

Wanted—Two first-class draftsmen on small interchangeable parts; applicants must be experienced on typewriter or other intricate mechanisms and must have had shop experience, as we want men capable of making working drawings for experimental work; those not having had such experience will not be considered; technical graduates preferred; factory located in Pennsylvania. Box 614, AMERICAN MACHINIST.

VIRGINIA

A Virginia furnace wants two competent engineers for power house; should have had experience with blowing engines, hoisting engines and air compressors. Address, "Virginia," AMERICAN MACHINIST.

WISCONSIN

Wanted—Good mechanical designers and detail draftsmen for machinery manufacture located in Wisconsin. Box 564, AMER. MACH.

For Sale

Patent For Sale of recent date on an automatic screw machine equipped with patented self-opening adjustable die head; especially adapted for making screws and small parts for electrical and typewriter work; machine can be seen in operation at L. & M. Wollstein, 16 John street, New York.

For Sale—Foundry and machine business in Superior, Wis., including real estate buildings and equipment; established over 20 years; fine business; located on railroad and harbor terminals; owner old, has retired; a great opportunity; at a bargain. Ernest A. Arnold, Superior, Wis.

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Belt Lacing Machines

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifter

The L. & D. Co., Boston, Mass.

Belting, Chain

Link Belt Co., Phila., Pa.

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Chicago Raw Hide Mfg. Co., Chicago, Ill.
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Bending Machines, Plate

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Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

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Bethlehem Fdry. & Machine Co., South Bethlehem, Pa.
Long & Allstatter Co., Hamilton, Ohio.
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Blocks, Die

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The "Half Moon" and the "Clermont"

The Reproductions of Henry Hudson's "Half Moon" and Fulton's "Clermont". Engine and Boiler of the "Clermont" Described and Illustrated

BY E. A. DIXIE

Henry Hudson (wrongly called "Hendrick Hudson," as he was an English navigator in the employment of Dutchmen) in his ship the "Half Moon," discovered the Hudson river in the beginning of September, 1609, and in 1807 Fulton's "Clermont" made her first trip from New York to Albany. These two great events in the history of the Hudson river will be commemorated by suitable exercises in the two weeks, September 25 to October 9, inclusive.

FIG. 1. THE "HALF MOON" FROM THE PORT QUARTER

The "Half Moon"

The people of Holland have built a reproduction of the "Half Moon," shown in Fig. 1. This ship was built from drawings and paintings of ships of that period, there being no authentic picture of the "Half Moon."

Her dimensions are as follows: Length over all, 74.54 feet; length between perpendiculars, 58.7 feet; breadth, 16.94 feet; depth, 10.08 feet; draft, 7.03 feet.

Her first official appearance will be on Monday, September 27, at which time she will be received by the commission's officials and take her place in the line of international war and merchant vessels. She will be manned by a crew of modern Hollanders, but they will be dressed in the costumes of Hudson's time, as shown in Fig. 2.

The Hudson-Fulton Celebration Commission have had built as near a reproduction of Fulton's "Clermont" as the shipping laws will allow.

The "Clermont" is shown in Fig. 3, lying at a wharf in Staten Island. The line cut, Fig. 4, shows her in elevation, plan and section. She is practically the same as the "Clermont" built by Fulton. The only changes were made in compliance with the laws governing steam vessels. The hull of the original "Clermont" was built in New York by David Brown. The first captain of the "Clermont" was James Winans, and the second captain was Samuel Wiswall.

The task of ascertaining the appearance of the "Clermont" a century after she was built was not an easy one, for the reason that while drawings of her engine are in existence, there is no contemporary picture of her hull. But from Fulton's statement concerning his first boat in the specifications upon which he obtained his second patent of October 2, 1810, and from other sources the following facts are now perfectly established: The original "Clermont" was 150 feet long and 13 feet wide, with 7 feet depth of hold. She drew 2 feet of water. Her hull (below the deck) had wedge-shaped bow and stern, cut sharp to the angle of 60 degrees. In horizontal plan her sides were parallel and she was almost wall-sided, being a very little wider on deck than on the bottom. Her bottom was flat with no keel, and she had two steering boards or lee boards to prevent drifting sideways. She had two masts, but no bowsprit or figurehead. She had two cabins, one forward and one aft. The tiller by which she was steered was at the back end of the after cabin, so that it was difficult for the helmsman to see what lay ahead. The engine was amidship between the two cabins, and was uncovered. The boiler was of copper. The paddle wheels, 15 feet in diameter, were uncovered, which resulted in drenching the passengers, and no guards protected the wheels from collision. Later, the paddle wheels were covered. To turn around, one paddle wheel was disconnected. The flywheels of the engine were outside of the hull forward of the paddle wheels, and revolved the same way. On one occasion, when one of the paddle wheels was disabled, it is said, paddles were attached to the flywheel and the voyage continued. This is either wrong or the reproduction is wrong, for the flywheels in the reproduction turn in the opposite direction to the paddles.

The naval parade will leave New York on Friday, October 1, and reach Newburg on the afternoon of the same day. The lower Hudson division will return to New York on the following day, Saturday, October 2, while the reproductions will continue their trip up the Hudson under the escort of the upper Hudson division of the fleet. The stops to be made north of Newburg are: Poughkeepsie (Dutchess county day), Monday, October 4; Kingston (Ulster county day), Tuesday, October 5; Catskill (Greene county day), Wednesday, October 6; Hudson (Columbia county

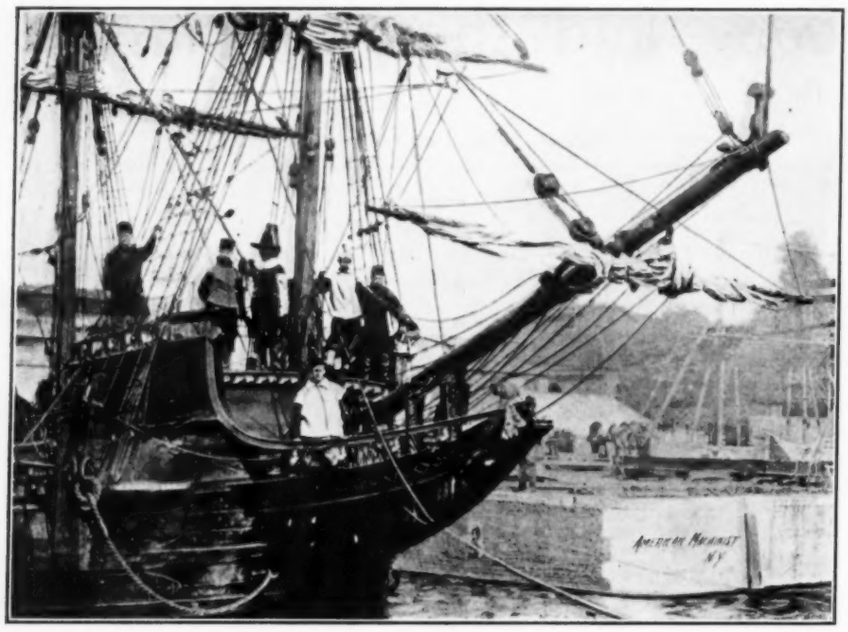


FIG. 2. FORECASTLE OF THE "HALF MOON" WITH CREW IN COSTUME

day), Thursday, October 7; Albany (Albany county day), Friday, October 8, and Troy (Rensselaer county day), Saturday, October 9. Elaborate local commemorative celebrations have been planned for each of these days, and they will center around the one-day stop of the fleet at each point named.

The "Clermont" will duplicate her maiden trip, starting from her original slip and landing at the same pier at Albany at which she tied up at the conclusion of her first trip 102 years ago. She, in company with the "Half Moon," will be escorted by a great fleet of war vessels of many nations, pleasure yachts and merchant craft from New York to Albany. This escorting fleet will constitute the greatest naval parade in the history of this country, and it will be in two divisions. The first, or lower Hudson division, will escort both ships from New York to Newburg, where that division will be met by a second or upper Hudson division of similar character, which will have started from Albany. At Newburg the two boats will, with appropriate ceremonies, be turned over by the lower Hudson division to the upper Hudson division, which will then escort them to Albany.

THE ENGINES OF THE "CLERMONT"

The engine of the original "Clermont" was constructed in England by Boulton & Watt and brought to New York in December, 1806. The engines of the "Clermont" were built by the Staten Island Shipbuilding Company, who also built the hull.

The line cut, Fig. 5, shows the general layout of the engine in plan, elevation and section.

Fig. 6 is a view of the engine exactly amidships. It shows the boiler front, at the back; the cylinder, and in front of the cylinder the air-pump rod, which passes through the hotwell. The pipe from the hotwell leading forward goes to the feed pump, which is located on the starboard side under the deck.

The two large gears are practically crank disks and kept in "time" by the two pinions which are mounted on a jack shaft.

SPECIFICATIONS FOR MACHINERY, STEAMER "CLERMONT"
GENERAL DESCRIPTION

Engine, single-cylinder, condensing, side-lever type; working pressure 20 pounds per square inch. Arranged to drive a pair of radial paddle wheels. Main paddle shafts inter-connected with a jack shaft on which are mounted two flywheels, arranged outside the hull. Jack shaft driven by the paddle shafts through a pair of two-to-one gear wheels; the large gears forming the sides of the main cranks. Engine keelsons, A-frame, and

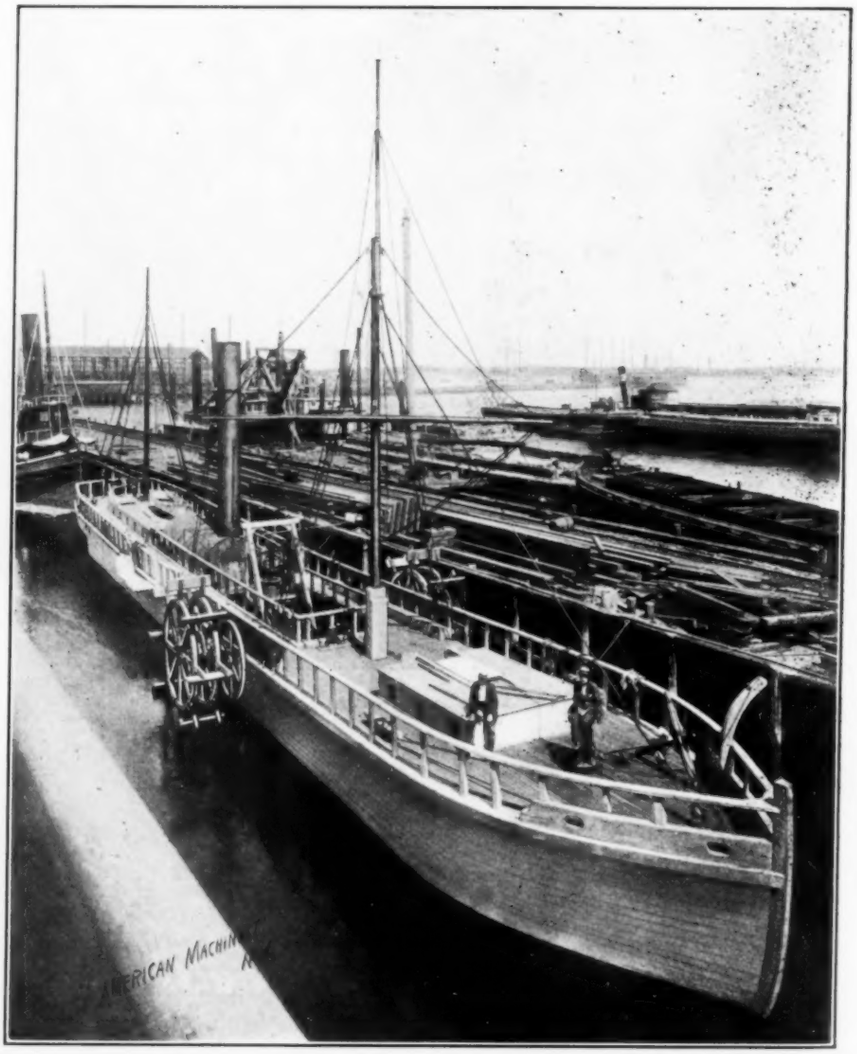


FIG. 3. THE "CLERMONT" LYING AT HER PIER IN STATEN ISLAND

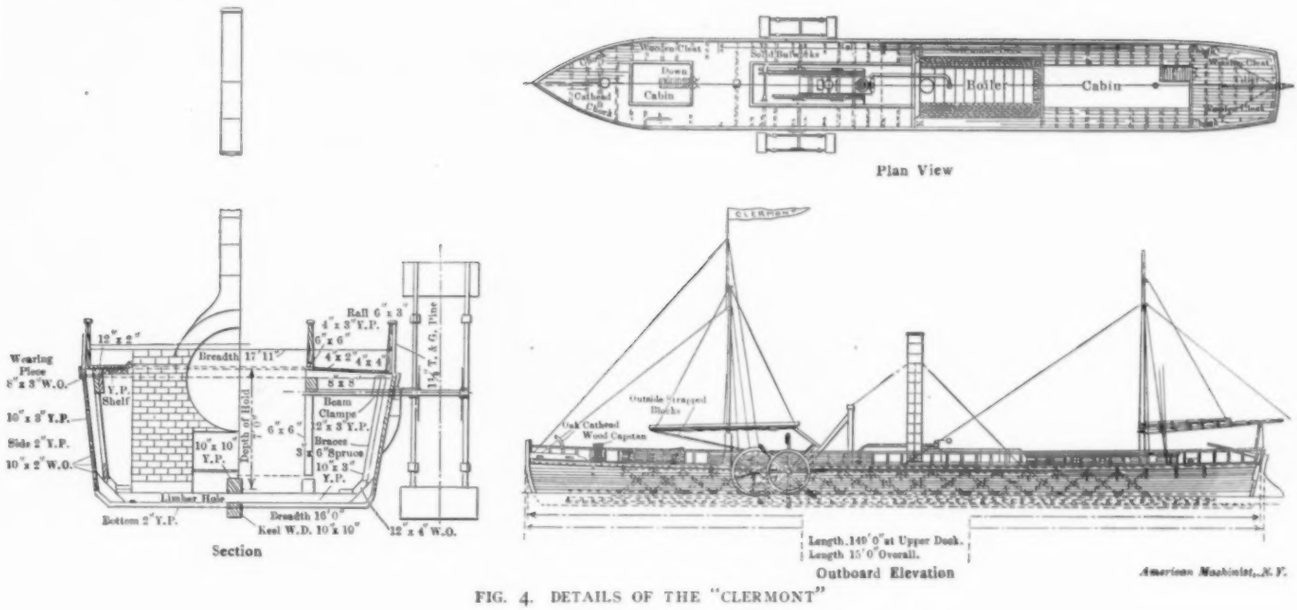


FIG. 4. DETAILS OF THE "CLERMONT"

guide gallows are of yellow pine. The cylinder is mounted vertically on a cylindrical condenser, which is connected to the air pump by a channel way of cast iron, which forms the bedplate of the engine. Air pump is vertical, single acting, of the bucket type, worked by links from the side levers, an open hotwell on top of pump. Feed and bilge pumps arranged alongside of the air pump, connected to and worked by the crosshead. Side levers with diagonal bracing T-shaped and mounted on a cross center shaft; pins fitted for connection to main crosshead and crank wheels. Main rods connecting to crank wheels and crosshead of wrought iron. Valves of the single poppet type; fitted in suitable cylindrical steam chests, arranged at each end of the cylinder, and worked by a rock shaft with wipers, toes and lifting rod. Single eccentric, with hook and shipping gear. Trip shaft and starting bar. Working parts of engine only to be finished. Duplex steam fire and donkey pump, size about 6 inches and 3x8 inches set and connected complete with all piping. All piping except main steam pipe to be of galvanized wrought iron. The whole machinery to be built, erected in hull, complete and tested for service. Requirements of the United Sates Steamboat Laws relating to this type of machinery to be complied with.

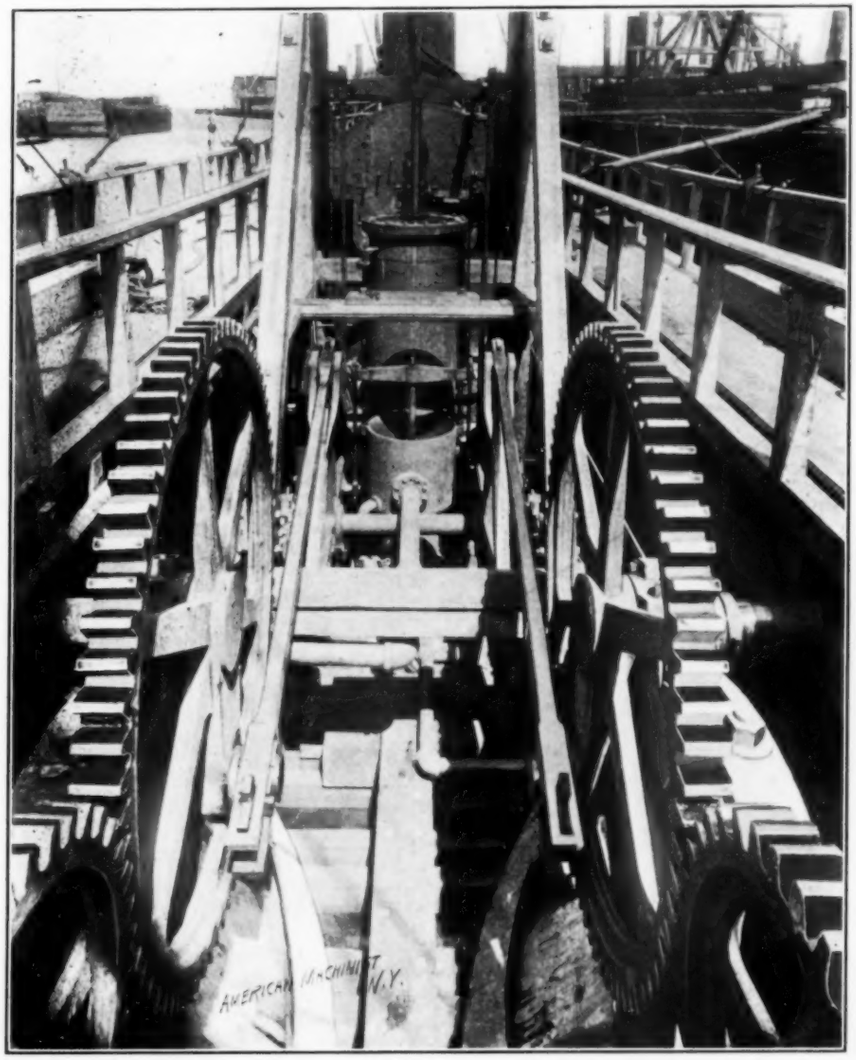


FIG. 6. THE "CLERMONT'S" ENGINE LOOKING AFT

Boiler

Single, cylindrical, return tubular type, set in brickwork, complete with stop and safety valves, feed and blowoff valves, gages, grates and stack.

Cylinder

Of cast iron, 24 inches diameter of bore and length for a stroke of four feet, complete with heads, piston, rod and stuffing box. Steam chests arranged at each end and fitted complete with single poppet valves, stems, lifters, rods and gear; side pipes, connecting steam chests also to condenser, nozzle for throttle.

Throttle

Butterfly type with gear complete. Blow-through valve and gear complete, including check valve.

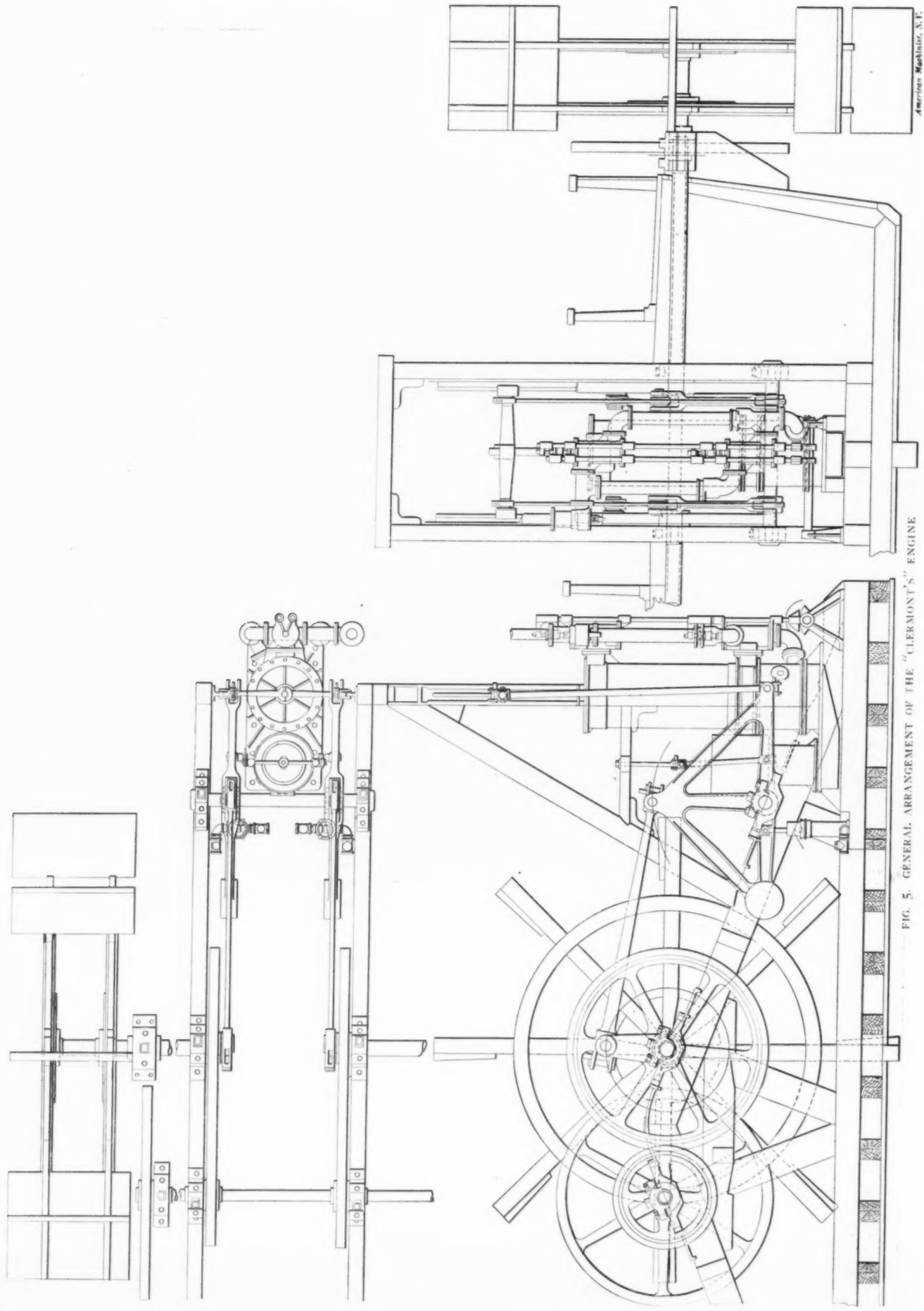


FIG. 5. GENERAL ARRANGEMENT OF THE "CLERMONT'S" ENGINE

Condenser

Of cast iron, cylindrical, about half capacity of cylinders; complete with injection nozzle, valve and gear.

Bedplate

Of cast iron, arranged to support condenser and cylinder, and cast with channel way and fitted with foot valve for air pump.

Air Pump

Of cast iron, brass-lined, single acting, capacity about 1 6/10 cubic feet. Bucket and rod of brass. Valves of rubber. Floating top and hotwell, pump fitted with crosshead and guides and worked by links from the side lever.

Feed Pump

One, single acting; capacity about 180 cubic inches worked by the air-pump crosshead; brass plunger and valves; pipes and regulating gear complete.

Bilge Pump

One, of copper or brass, about 300 inches capacity, complete with valves and piping, work by the air-pump crosshead.

Side Levers

Of cast iron mounted on a wrought-iron center shaft and supported by pillow blocks; ends for connecting rod to be forked and fitted with wrought-iron pins; counterweights to balance piston, rod, crosshead, side links, air pump and gear.

Main Crosshead

Jaws and suitable guides, all of cast iron.

Side Links

Of wrought iron, smoothed, forged, adjustable end connections with brass boxes.

Main Shafts

Of wrought iron supported by suitable pillow blocks.

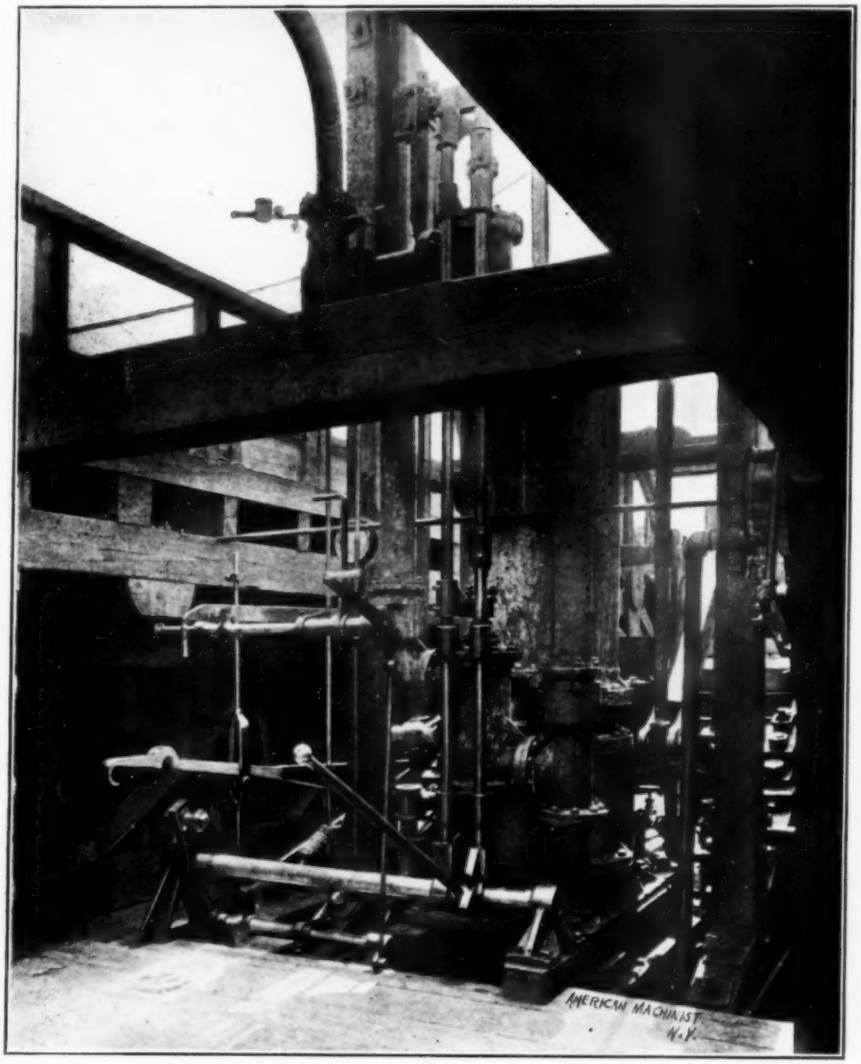


FIG. 7. THE STARTING PLATFORM OF THE "CLERMONT"

Jack Shaft

Of wrought iron supported by suitable pillow blocks.

Flywheels

Two of cast iron, section of rim about 4 inches, keyed to shaft.

Gear Wheels

Of cast iron, machine molded, keyed to shafts; large wheels fitted with crank pins.

Main Connection Rods

Of wrought iron, smooth forged, adjustable end connections with brass boxes.

Paddle Wheels

Fifteen-foot diameter over all, fitted with 8 paddles, 4 feet long; and 2 feet wide; arms, rims and paddles of oak, centers of cast iron, keyed to shafts.

Boiler

Of marine steel, 5 feet 6 inches in diameter, 16 feet long, shell ¼-inch thick; heads 5/16 inch thick, braced for a pressure of 25 pounds per square inch, forty-six 4-inch tubes. Manholes, plates, clamps and gaskets, soft plug, main and auxiliary stop valves, feed and blowoff valves, lever safety valve; try-cock, steam-whistle, four lugs of steel for carrying boiler to be supported by four steel or iron pillars which are to be bolted to keelson and braced.

Setting

Of hard brick, laid in cement mortar, fire-side line with firebrick, set in fireclay.

Front

Of cast iron complete with doors to furnace and ashpit, which are to be wrought iron; front to be through bolted, end to end, of brickwork, also to the keelson. Back end of setting, crossbolted with proper staffs.

Smoke Box

Of sheet steel, including gear, which is to be fitted with proper hinges and clamps.

Stack

Of steel 38 inches diameter, about 24 feet high. Thickness No. 12. Courses 24 inches high; bands top and bottom 2x½ inches. Shrouds of hemp, with about 3 feet of ⅜-inch chain at top ends.

Grates and Bearers

Also bed bearers of cast iron.

Hearth and Ashpit

Of hardburned, common brick, laid in cement mortar on wooden floor in hold.

Casing

Over boiler of steel plate about No. 12 Birmingham wire gage courses 24 inches wide, riveted with large button-head

FIG. 5. GENERAL ARRANGEMENT OF THE "CLERMONT'S" ENGINE

rivets; manhole at back end, with plates and grabs complete; stack nozzle on front end. Casing to be either electroplated with copper or possibly copper painted as may be hereafter decided.

Fig. 7 is a view of the starting platform taken from the side of the boiler and in line with the front of it. It shows the starting bar, eccentric-rod lifting gear and throttle.

There is not such a great difference between this engine and the average ferryboat engine of today. The hooked eccentric rod is practically the same, even to the hook on the end, as those used in many of the older New York ferries. The boiler will carry 25 pounds of steam and the engine will probably make about 15 revolutions per minute.

Making a Set of Blanking and Piercing Tools

By H. Harris

For making piercing and blanking tools for small work, where a solid die is to be used, a quick and accurate method is here shown. This method is not claimed as a standard for all stamping tools, as the methods of manufacture are governed, always by the size, shape, quality of work required, and also by the machinery and appliances at hand. But this method is

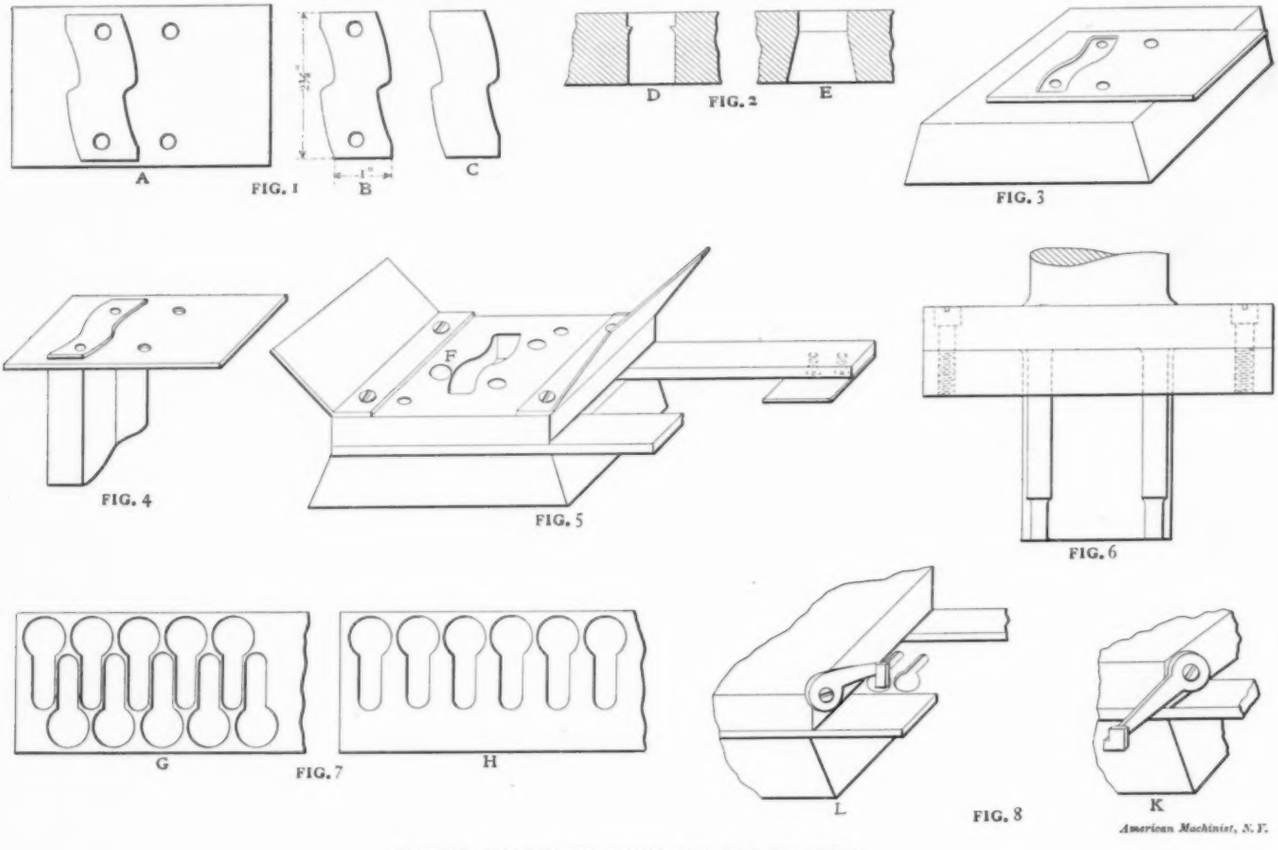


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6 FIG. 7 FIG. 8

American Machinist, N. Y.

MAKING A SET OF BLANKING AND PIERCING TOOLS

As has become well known the use of steel in passenger car construction is no longer an experiment but has come into increasing daily use. It lends itself to the skill of the artisan and reduces risk of serious accident to the passengers. It is more available than wood, produces a plainer effect, is easy to clean and weighs no more than a wooden car if economically designed. The initial cost per passenger is about the same as for wooden coaches, and the maintenance is considerably less. The life of a coach is greatly increased by the use of steel, and damage suits, as well as suffering in case of accident, greatly reduced.

the die is lined off from the female templet and the blank hole only is drilled and roughly filed out to shape. The hardened blank is now placed upon the die so as to cover the rough hole, and with the aid of a hand press with planishing tool in the ram the hardened blank is driven into the die flush with the top; a little tallow will help in this operation. If there is a good, steady pressure, the planishing tool covering the hardened blank, and the die roughed out enough, it will be found that the blank will sink readily into the die.

The blank is now knocked out and the die will appear in section as at *D*, Fig. 2. With the aid of a rough file in a filing machine a 1-degree clearance angle is put on up to the impression made by the blank, as represented at *E*, Fig. 2.

We have now a die with the first ⅛ inch parallel and under size, but of the correct shape, and it is an easier job to fit the proper templet into the die at an angle of ½ degree and shut daylight out at the top. With experience the hardened blank can be increased right up to the size of the templet. This, however, entails greater care in the making and using while leaving less trouble in fitting the finishing templet in.

After the templet is fitted, the piercing holes are located by the female templet which is located in position on the die by the male templet, which is half in the female templet and half in the die, as indicated in Fig. 3. At the same time the

For a set of piercing and blanking tools three templets are needed, as shown in Fig. 1. *A* is a female templet, the width of the stock required, with a blanked hole and pierced holes in proper relation to each other. *B* is a cast-steel male templet or blank, which will fit tight in the female templet, and it generally is either soldered or riveted to a short rod to facilitate trying in the die. *C* is a cast-steel blank without pierced holes and about 0.002 inch smaller than the blank proper; it should be not less than ⅛ inch in thickness, and should be hardened and tempered to a purple. For a blanking tool only, the female templet is not required, only the two males being necessary.

In making piercing and blanking tools, the best and quickest for small irregular shapes like the one shown.

position of the stock is marked off. The piercing holes are drilled and reamed with a 1-degree reamer, and the screw and steady-pin holes drilled and tapped. The die is now ready to be hardened and tempered, after which it should be cleaned and the templet fitted in again.

The punch is lined off, machined and fitted into the die. To drill the locating-pin holes in the punch face, the male and female templets are used together as a locating jig, Fig. 4, the punch and male templet both being entered into the female templet half way. These holes should be drilled right through the punch and are generally smaller than the pierced holes, the locating pins being turned with a shoulder. These pins should be hardened and tempered and a driving fit in the punch. After it is drilled, the punch is hardened and tempered, the back being left soft enough to upset. After hardening it should be tried again in the die.

The guide-stripper plate is now lined off from the die, drilled and filed out to a tight sliding fit for the punch, great care being taken to keep the hole absolutely square with the surface of the plate. The punch is entered through the guide and about ⅛ inch in the die, tried with a square and the plate and die clamped together while the screw and steady-pin holes are drilled, after which the hole for the finger register is drilled. This register is an adjustable one fixed and operated by the press and works through holes *F*, Fig. 5, in the guide plate. The plate is now fastened to the die and the piercing holes transferred to it; these holes are afterward opened out to take the piercing punches. The punch-guide plate is then case-hardened round the blanking and piercing holes only, to prevent the punches from wearing the holes large. The stock-guide strips are located on the die by the templets and clamped there, while the screw and pin holes are drilled. The small plate screwed to the end of the back strip, Fig. 5, is used to hold the stock level with the die face.

The punch holder is drilled and filed out, the blanking punch driven in and the back end upset; it is essential that the punch shall be in line with the stem of the punch holder. The punch is now entered into the die about ⅛ inch and parallel strips placed between to keep the die and punch plate apart, the whole being held together while the piercing holes in the die are transferred to the punch plate. These holes are opened out to take the piercing punches which are driven in and the top upset, after which the punch plate is secured by screws to the punch holder and the punches ground level, as in Fig. 6, when the locating pins are driven into the blanking punch. The die is now ground up, and the stock guides and punch guide screwed and pinned on.

If properly made, this tool is easily set into the punch press and the punches will not shear the die even when cutting a portion of a blank, as both the blanking and piercing punches are well supported by the guide stripper, which should be kept well lubricated.

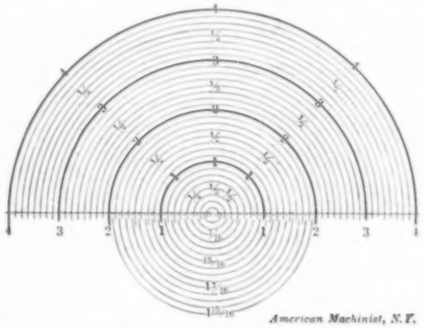
The guards, shown in Fig. 5, are simply ⅛-inch iron secured by the screws that hold the guide plates in position. They form a cheap and effective means of preventing the operator's hand from getting between the punch and die while engaged in feeding the stock through.

If, in order to save stock, it is required to cut blanks into different positions in the stock, as at *G*, Fig. 7, and yet the cost of making a double punch and die is considered prohibitive, the stock can be fed through once, as at *H*, Fig. 7, then turned and fed through again. The position of the second blank in relation to the first is obtained by the side register, shown in Fig. 8. This is simply a plate fastened to the guide plate by a round-head screw. When not in use it is swung back, as shown at *K*; it is thrown over when required and locates the stock for the second feeding by falling into the blanked hole of the first feed, as at *L*, the stock being held up against it. After the finger register has picked up the feed the auxiliary register is thrown back out of the way. This is a simple and effective method of locating for double feeding of stock.

Draftsman's Radius and Center Finder

By T. S. Quay

In drawing irregular curves one can often obtain close approximations with two or more arcs. This method would usually save time were it not for the difficulty of finding center points for the compass. Again, in copying drawings—to the same or a different scale—and in making details from an assembled view, we often come across curves whose centers we have to fish for. Sometimes an irregular curve may be drawn in free hand in an assembled view, which in the larger detail will require the use of the compass—and again necessitate fishing for centers.



DRAFTSMAN'S RADIUS AND CENTER FINDER

As a solution of this difficulty we have devised a center finder which will easily and rapidly give both the radius and center of a roughly-sketched-in curve, or of an arc to connect three given points, and will also give the center of an arc of given radius that will make it tangent to two given lines.

It may be laid out, as shown in the sketch, upon tracing paper, but gelatin will be found preferable and a piece of transparent celluloid best of all. When using tracing cloth the curves are inked in, making the whole-inch sizes either heavier, as shown, or in color by red ink. On gelatin or celluloid, however, ink will easily rub off. It is, therefore, desirable to engrave the marks with the dividers and then fill in with a colored chalk or ink, using a different color for the even inches. The sketch shows curves increasing by sixteenths from ⅛ to 2 inches radius, and by eighths from 2 to 4 inches radius. To avoid confusion by having lines too close together all the curves of radius varying by eighths have been drawn above the horizontal diameter and those between—the sixteenth sizes—below. A small hole is made through the center for marking with the pencil or dividers.

To avoid shadows, particularly when the celluloid, which is of some thickness, is used, it will be found desirable to use the finder with the engraved side down. It is, therefore, advisable either to mark the figures on the other side, or mark them so that they can be properly read from the other side.

Now to illustrate its use. Suppose we have a curve roughly sketched in whose center we need, in order to be able to use the compass, or some points we wish to connect with an arc. We simply put our "finder" over the paper, move it around until we strike the right circle and then mark through the center. When we want an arc of given radius tangent to given line we put the pencil on the required curve, move around until it is tangent, then mark through the center.

In working from a copy the finder is put over the copy, moved around to get the right curve and the radius read off on the graduations. The compass may then be set to that size, or, when a different scale is desired, the required size is easily obtained.

Naturally each draftsman will make some changes to suit his own particular tastes and requirements—extending the limits, varying the graduations, making complete instead of semi-circles, or in various ways that will suggest themselves. But an article on the general lines of the one shown will prove—as it has in our drafting room—a great help to rapid drafting.

The coal production in the United States in 1908, as reported by U. S. Geological Survey, was 415,842,698 short tons, having a spot value of $532,314,111. Of this total 83,268,754 tons with a value of $158,178,849 was Pennsylvania anthracite, and 332,573,944 tons, worth $374,135,262, was bituminous and lignite.

Principles and Applications of the Gyrostat

Seven Simple Rules State the Principles Governing the Forces and Movements of Gyrostatic Action and Aid the Designer in Using the Device

BY HORACE B. MC CABE

The gyroscope is an old and familiar toy which has always been a source of speculation. The peculiar actions of the rapidly rotating wheel are seldom correctly explained and a wrong impression exists generally regarding the nature of these actions. Renewed interest has been taken in the device within the past two years on account of two very interesting successful applications to practical uses, by Doctor Schlick and by Mr. Brennen.

As the name "gyroscope" is more suggestive of the toy I will hereinafter use "gyrostat" instead, as that seems better adapted for the practical machine.

Doctor Schlick has mounted a large, steam-driven gyrostat in the hold of a 200-foot torpedo boat to prevent rolling in rough water. Mr. Brennen has built a locomotive that will run on a single rail and maintain its equilibrium above it by using two motor-driven gyrostats. So far, however, no extended use of the devices has developed.*

As the matter is of interest and as many erroneous impressions exist in regard to the nature of the action of the gyrostat, the following is written with the hope that it will correct these impressions and set forth something substantial in the way of rules which may be of use to the engineer in the design of new applications of the device.

As we are no doubt all aware, the gyrostat in its elemental form is simply a flywheel provided with means for giving it rapid rotation, and mounted in such a way that its axis can tip in any direction. The most familiar form is shown in Fig. 1, which shows the common toy gyroscope. Fig. 2 shows the same form but provided with a counterweight and intended for laboratory use. By this form of the device it can be demonstrated that when the weight of the wheel and frame overbalances the counterweight the whole thing will revolve on the standard in the same direction as that of the underside of the wheel. When the counterweight is adjusted to overbalance the wheel and its frame the movement about the standard will be in the opposite direction.

Description of Mechanism and Actions of Gyrostat

These forms, however, are not best adapted to the intelligent study of the action. We obtain correct conceptions more easily when we imagine the rotating wheel floating in space as in Figs. 4 and 5. The way of mounting that most nearly approaches this condition is shown in Fig. 3 in which the wheel is mounted in the gimbal rings N and R. The outer ring R is made to swing on trunnions in bearings at A and B in a stationary base and the inner one N is pivoted transversely in R at C and D. There should be a brake provided to damp the swinging movement of the ring N on its axis $C D$ and also a means for locking it rigidly from movement. The brake is shown at D and consists of a flat spring which may be adjusted to tension against the brake disk on N by the thrust knob shown. The locking means is shown at C and consists of a set screw b which may be brought to bear against the disk on N, thus locking it in any position desired. The normal position is as shown with the rings perpendicular to each other, although it is not necessary that the ring R lie in a horizontal plane. The wheel may be given its rotation in the usual way by winding a string on the shaft.

When the wheel is thus put into rapid rotation the following phenomena may be observed: When the finger is pressed on the ring R at D the wheel will tip on the axis $C D$ in one direction while if the pressure of the finger is transferred to C it will tip in the opposite direction. While the wheel is tipping a decided resistance to the pressure will be felt. If the pressure is increased the tipping will be more rapid and the downward movement of the finger much less, due to a greater resistance which can be felt.

If a strong pressure is applied, the wheel will tip very rapidly around to a horizontal axial position while no perceptible downward movement of the finger will be noticed. But, however, as soon as the axis does reach the horizontal position all the resistance ceases and the sensation will be as if a rigid support had been underneath and was suddenly removed. If the ring R is struck a forcible blow at C or D with the fingers the sensation will be much like striking a very stiff spring. No permanent downward movement will occur, but the wheel will tip some and remain so.

If the experiments are performed with the brake spring brought up to tension the tipping action of the wheel will be slower and at the same time less resistance to the pressure will be felt and the finger will go down more rapidly. If the binding screw is set so that no tipping of the wheel on

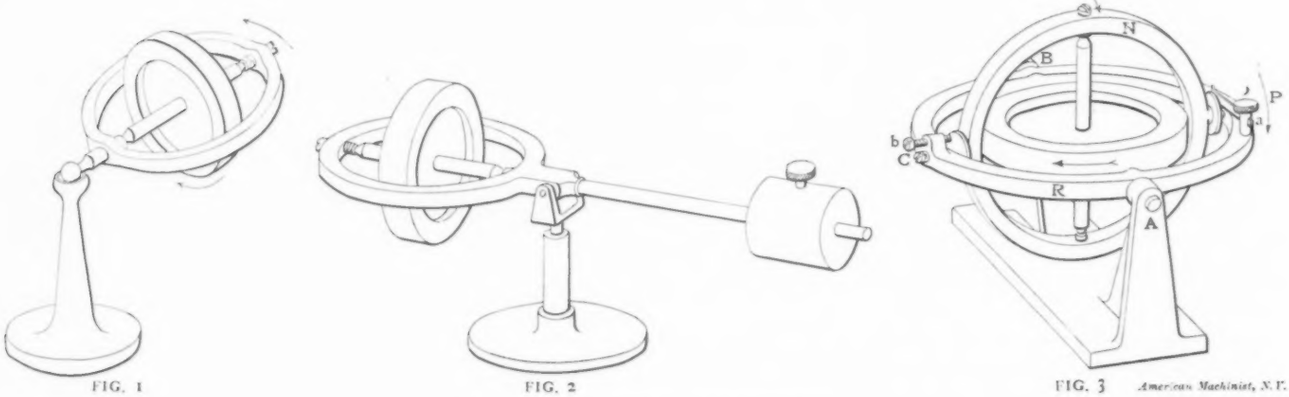


FIG. 1 FIG. 2 FIG. 3 *American Machinist, N.Y.*

DIAGRAMS ILLUSTRATING THE GYROSCOPE

*In his article in *Nature*, March 12, 1908, Prof. John Perry goes deeply into the theory of the action of these devices of Doctor Schlick and Mr. Brennen.

the axis $C D$ can occur no resistance to the pressure will be felt and the finger will go down as easily as if the wheel were not rotating.

As would be expected, if instead of applying the pressure to the ring R it is applied to the ring N in a way tending to swing it on the axis $C D$ there will occur a tipping movement of the wheel and likewise ring R on its axis $A B$.

In the experiments one thing is strikingly evident, that a tipping movement of the wheel through a large angle is not necessarily attended by any extensive movement in the direction of the pressure at the point where it is applied, and, indeed, if the pressure is quite strong and the brake spring entirely free, there will be no perceptible movement at the pressure point, while the wheel is tipping, and the stronger the pressure the less will be that movement.

In all cases the direction of the tipping movement is at right angles to the direction of the pressure producing it and depends on the direction of rotation of the wheel. It will be found that if the direction of rotation is clockwise, as shown by the arrow on the wheel, and the pressure is applied as shown by the arrow P the wheel will tip as shown by the arrow M. This being true one would naturally expect to find that a pressure on the ring N resisting the movement M would resist the pressure at P. The natural assumption might be that if the pressure will cause a movement, a resistance to that movement should act as a resistance to the pressure causing it. But in this case the contrary will be found to be true and the pressure applied on the ring N in the direction opposite to the arrow M will cause the end D to move down in the direction of P.

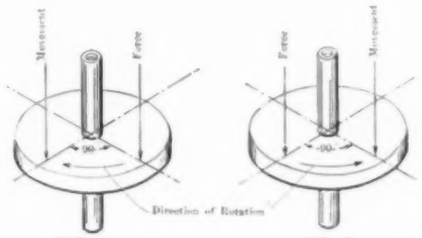


FIG. 4 FIG. 5

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DIAGRAMS OF FORMS AND MOTIONS OF GYROSTAT WHEEL

General Rules Governing Gyrostat Action

Following are given a few general rules deduced from the experiments. In connection with these rules, Figs. 4 and 5 are given in which the wheel is viewed abstractly as if floating in the air and rotating at a high speed. In each figure the direction of rotation is shown by the curved arrow. The force is assumed to be applied near the periphery and in a direction always normal to the plane of the wheel as the arrow indicates. A jet of compressed air impinging on the side of the rim would exemplify this. The movement resulting from the force is also represented by an arrow in a similar position. This arrow merely represents the direction in which the side of the wheel will start to tip or swing about its center when the jet of air is applied and is tangent to the actual direction of the movement at that point. The above being made clear, here are the rules:

1. The force arrow and the movement arrow are in planes normal to the plane of the wheel and always at right angles with each other. 2. The movement arrow, when considered ahead of the force arrow with regard to the direction of rotation, will have the same direction as the force arrow. In other words the force and the movement are in the same direction when the latter is considered at a point 90 degrees ahead of the former. 3. All of the movement will occur at the movement arrow and none at the force arrow. 4. As long as the movement can freely take place at the movement arrow the force at the force arrow will be opposed by an equal force. 5. Any damping effect on the movement to retard it will cause the movement to be slower and a consequent movement will occur at the force arrow *in the direction of the force*. 6. If the wheel be completely restrained from its movement at the movement arrow, all the movement will occur at the force arrow and no resistance whatever will oppose the force. 7. The velocity of the movement will depend on the magnitude of the force. An increase in the force will produce an increased velocity of movement.

Rule 5 will be verified when it is considered that the damping effect must be produced by a force opposing the movement and by Rule 2 this will cause another movement in the same direction as this opposing force and at a point diametrically opposite the force arrow and thereby lessen the opposing resistance at the force arrow.

Referring back to Fig. 1 it may now be plain that the force causing the movement about the standard is the weight of the wheel and ring. If the wheel speed could be kept constant and there were no friction at the swivel point on top of the standard the wheel and ring would revolve around it in strict accordance with Rule 1 and it would maintain its axial angle in accordance with Rules 3 and 4.

The fact that the wheel will gradually sink, however, even though the rotative speed be constant, is in accordance with Rule 5, the friction on the standard being the damping effect.

Referring to Fig. 2 in which the direction and amount of the force may be adjusted by the counterweight, the direction of the movement about the standard will be in accordance with Rule 2 and the variation in the velocity of the movement will be in accordance with Rule 7. Rule 6 may be strikingly verified by placing some rigid obstruction in the path of the weighted arm.

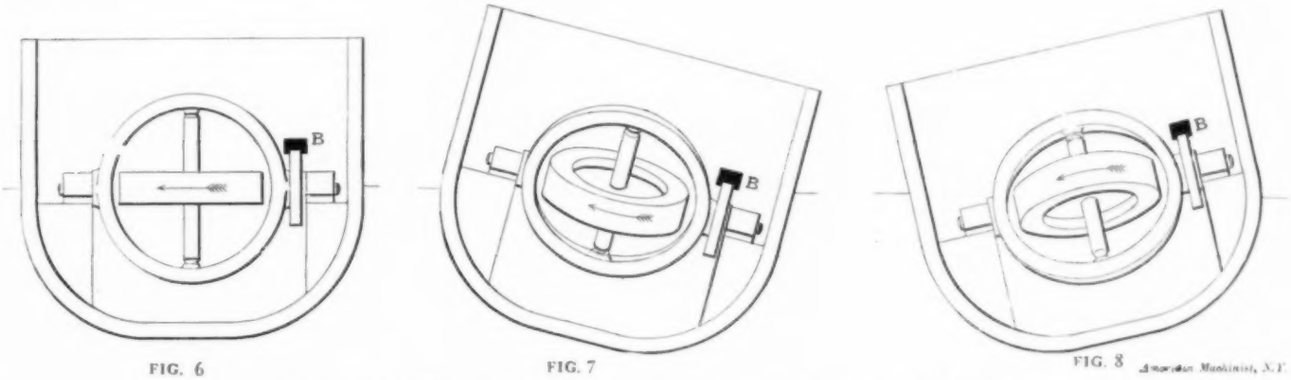

FIG. 6 FIG. 7 FIG. 8

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DIAGRAMS OF DOCTOR SCHLICK'S APPLICATION OF GYROSTAT TO A TORPEDO BOAT

A top with a sharp point spun on a wood table where it may find a stationary rotation center will behave exactly like the wheel in Fig. 1. It is a familiar sight to see a skilful bicycle rider round a corner at high speed without touching the handle bars. He does this by simply leaning inwardly, which causes his front wheel (which is a gyrostat) to swing in the direction he is leaning. This is in accordance with Rules 1 and 2. A rolling hoop will not fall, because as soon as it begins to tip to one side or the other it

will, in accordance with Rules 1 and 2, begin to turn in the direction of the tipping, which will bring the lower part of the rim again under its center of gravity. Looking at it from another point of view, the hoop being free to swing in either direction at right angles to the force which acts to tip it this force will be resisted by an equal opposing force and, according to Rule 4, no tipping can occur.

Doctor Schlick's Application of the Gyrostat

The principle of Doctor Schlick's application of the gyrostat to a ship is shown in Figs. 6, 7 and 8, which represent diagrammatically the gyrostat in the hold of a ship, the means of rotation not being shown. At *B* is a brake which it is assumed has some means of adjustment for tension, so that any desired damping effect on the tipping action of the wheel may be procured. Suppose the wheel maintains a high rotative speed in the direction of the arrow. If the position of the wheel when the boat is normal is as in Fig. 6, it will, when the boat rolls, tip as shown in Figs. 7 and 8, and offer a great resistance to the rolling action. Rules 3 and 4 will indicate that it is not necessary that the boat actually roll any perceptible amount in order to make the wheel tip through a large angle, and in point of fact, it is reported that the boat may be standing apparently still and upright while at the same time the wheel is tipping violently back and forth.

The office of the brake is merely to prolong the tipping action to suit the period of oscillation of the boat. According to Rule 4 it is evident that if the brake is set tight so that the wheel cannot tip, no resistance to the rolling will exist. It may be reasoned, however, that according to Rule 1 the rolling action in this case will have a tendency to cause the boat to pitch, while any pitching of the boat will have a tendency to cause it to roll.

Mr. Brennen's Application of the Gyrostat

The application of the gyrostat to the monorail car by Mr. Brennen is shown diagrammatically in Figs. 9 and 10. Two gyrostats are used and made to run in opposite directions, so that there will be no ill effect on the car in rounding curves. They are constrained to swing in unison by means of the bevel gears and shaft at *S*. The elemental parts of the machine may be seen to correspond with those in Fig. 3. The frame *R'* corresponds to the ring *R*, and the rings *N'* to the ring *N*. The axis *A' B'* corresponds to *A B*, and passes through the shaft *T*, which supports the frame *R'*, and is mounted on bearings *F* rigid with the car. The rings *N'* swing on the axis *C' D'*, which correspond to the axis *C D*. The frame *R'* has a lug *E* at its lower end embraced by a fork made fast to the car, which allows the frame *R'* a very small amount of swing. The wheel shafts have at their outer ends the friction wheels *c* and *d*. Underneath these and extending in the directions shown in Fig. 10 are the runways *H* and *K*, which are fastened rigidly to the car.

If the car starts to tip to the right both wheels will, according to Rule 2, swing toward the position shown by the dotted lines, Fig. 10, and at the same time the runway *H* will move up to contact with the friction wheel *c* which will try to roll forward thereon. The pressure on the wheel axis caused by this effort to roll forward is in a direction to cause a movement of the car to the left. When this begins to occur the runway *H* will lower from *c*, and there being no runway

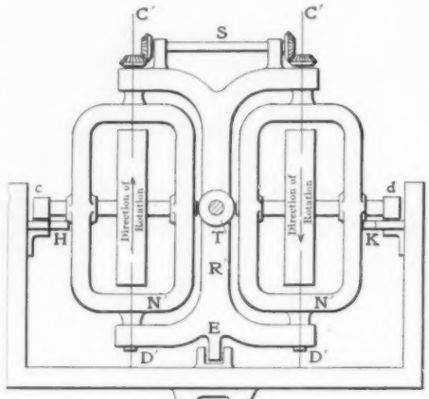


FIG. 9

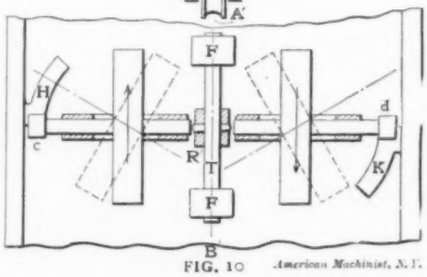


FIG. 10 *American Machinist, N.Y.*

DIAGRAMS OF BRENNEN'S APPLICATION OF THE GYROSTAT TO A SMALL LOCOMOTIVE

under *d* in this position of the wheels the fork will engage the lug *E*, and as the movement to the left still continues the wheel will in acordance with Rule 2 swing back into axial line again. Continued movement of the car to the left will cause the reverse of the above sequence of actions, and the runway *K* will move up to engage the friction wheel *d*.

The movements of the wheels will not be to the extent shown by the dotted lines, and the tipping of the car under normal conditions will be unnoticeable. This is the most interesting and wonderful of all applications of the gyrostat.

When standing still the center of gravity of the car will adjust itself always exactly over the rail. The weight of a passenger placed on one side of the car will cause that side to go up. A pressure such as the wind against one side will cause the car to lean to that side until the pressure is just balanced. In rounding a curve the car will lean inward just the correct amount.

Machine Molded Ingot Molds

By E. H. Mumford

It has not been often that the method of producing the rough casting in the foundry has had immediate and direct interest for the machine shop, as when the machine shop receives a rough casting, the question of how that casting was made does not interest it. The quality of the casting, however, is a matter of the greatest import to the machine shop, as castings too hard to be worked, without great loss of time and tools, may be practically worthless; or castings too crudely shaped to fit their jigs may also be valueless.

By sufficient care both softness and correct form in castings may be obtained from the foundry, without the intervention of machinery in the sense that molding machines are machinery. These have been used economically in the molding of gears, especially in large sizes, and they were so accurate that, when correctly centered in the machine shop, they would run almost like cut gears. In no other point, however, does the question of whether a molding machine had been used or not to produce a casting interest the machinist.

Something less than a year ago, when designing and furnishing molding machines for making molds for steel ingots, an expert of one of our largest steel works remarked that, "while the machines we were offering for making the outside of molds were satisfactory, it was the inside of the mold, the part which shaped the liquid steel into the ingot for rolling that most concerned them."

This led, last December, to an experiment in which one of our 10-inch jolt-ramming machines was loaded to more than twice its capacity and served with air at 140 pounds pressure per square inch. The first core was successfully jolt-rammed on this for a standard ingot mold which, including the print, measured 7 feet in hight and 31½x28½ inches at its base. This core was rammed 82 blows on the small machine. Immediately after this, a 16-inch machine of proper capacity for this work was ordered, and since May 30 last, it has been running without intermission, and producing ingot mold cores of the above dimensions with 2 men at the rate of 4 cores an hour, whereas, previously, it had required 5 men to make 16 cores a day.

The important fact in this is that the cores produced, being rammed with absolute uniformity throughout their whole length, produced ingot molds with straight internal surfaces that were free from the

waviness experienced from the necessary irregularities in ramming by hand, where the sand channel between the core barrel and the core box are as deep, narrow and obscure as in this work.

It has yet to be learned how much is to be gained in the durability of the ingot molds or in the rolling operation on ingots that are smoother on their surfaces, owing to their being stripped from straighter molds than have been possible where the ingot-mold cores have been hand-rammed as heretofore. The works, however, in which machine-molding methods are being adopted for the complete production of ingot molds anticipate great advantage in these directions.

Cutting a 16-foot Worm Wheel and Its Worm in a Lathe

One of the most interesting repair jobs we have run across in a long time is shown in the accompanying illustration. A large worm-driven mill, with a worm wheel between 15 and 16 feet outside diameter, went out of commission, and it was necessary to get it into operation at the earliest possible moment.

This was the proposition put up to F. C. Thornley, superintendent of the Builders' Iron Foundry, Providence, R. I., and he guaranteed to have the machine in operation in six weeks. There was no time to make a complete new worm wheel, so that it became necessary to turn off the teeth on the old wheel and put on a new rim. This increased the diameter of the worm wheel, and as it was necessary to maintain the old center distances, it, of course, required a somewhat smaller worm than before, which led to the making of a Hindley form of worm to secure all the bearing possible.

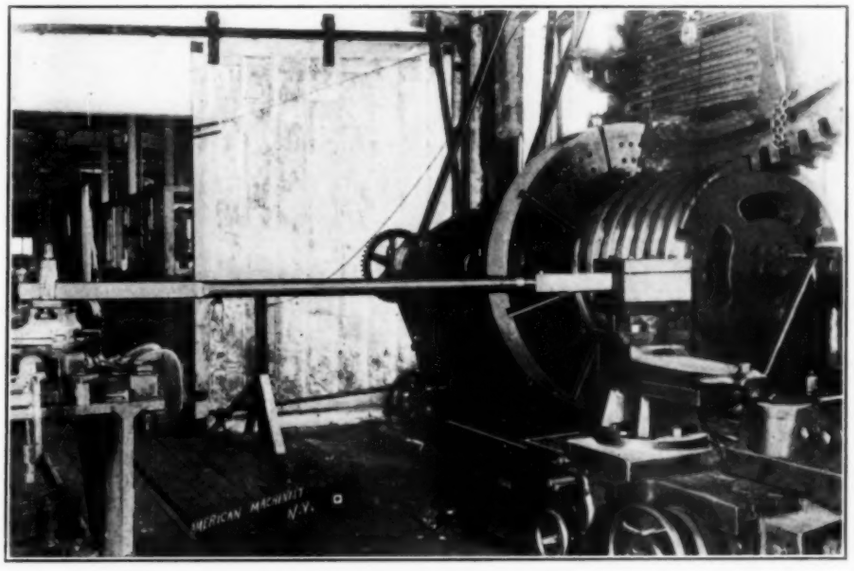


FIG. 1. CUTTING A 36-INCH HINDLEY WORM

The new wheel's rim was made in eight sections, the pitch diameter being 16 feet, while the worm was a double thread, 4 7/16 inches pitch, making it an 8⅞ inches lead. The working depth of the tooth was 3 inches, with ¼-inch clearance, and the worm wheel had a 10-inch face. The worm itself had a minimum pitch diameter of 35⅜ inches, was about 4 feet long and weighed 4 tons. Each of the eight segments weighed about 3300 pounds.

Cutting the Worm

Fig. 1 shows the way in which the Hindley worm was cut in an ordinary lathe by the use of a radius bar representing the worm wheel. This was easily made by fastening a substantial tool slide on the bench at the proper distance, fastening the end of the radius bar in the tool post as a pivot or fulcrum, and allowing the cutting tool to swing in its proper arc as it was fed along by the lathe carriage. The mark on the faceplate indicates the starting point for the first thread, the other mark being at the opposite side of the faceplate. The illustration shows a section of the rack being tried into the worm after the thread was about completed.

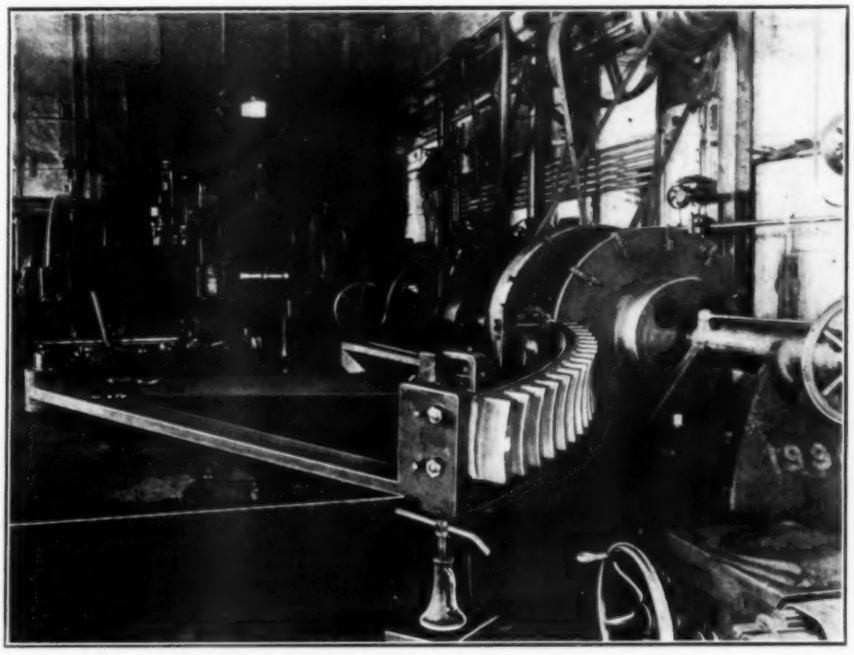


FIG. 2. CUTTING A 16-FOOT WORM WHEEL IN A LATHE

Cutting the Segments

Fig. 2 shows how the segments of the 16-foot worm wheel were cut in a small lathe. First, a large milling cutter was made, representing the small diameter of the worm and fitted with inserted teeth, as shown. The cutters in place were used in roughing out the teeth, having stepped edges, as can be seen on close inspection.

The segments to be cut were held on the fixture shown, this being made so that the segments were at the proper angle to correspond with the lead of the worm, each segment being held in its correct position by the clamp shown. In this way each of the teeth was cut, a spacing rig being devised for locating them as accurately as necessary, and the eight segments were cut in a considerably shorter time than was estimated and the new parts went into place without difficulty.

The whole job, from the making of the patterns to the installing in the mill, took less than five weeks and allowed the mill to begin operations a week earlier than was expected. This is a good indication of what can be done with comparatively few facilities by men who are thoroughly well grounded in the foundation principles of shop work. It is interesting to add that a number of shops with a much larger tool equipment than this, refused to tackle the job.

A Curious Power Drive

By Du Pont

Dixie seems to have come across some interesting specimens of ancient history among machines, but I don't think he ever came across a more curious arrangement of shafting than the accompanying.

The motive power was a 50-horsepower steam engine of the horizontal slow-speed type, 12-inch cylinder, 18-inch stroke, making 80 revolutions per minute. The boiler pressure was about 100 pounds per square inch. The engine rarely indicated more than 52 horsepower.

The accompanying plan shows the general arrangement of the drives and the machines. The planers Nos. 4 and 5 were geared with bevel wheels and the others with spur gearing, all cast steel and *not machine cut.*

The planers Nos. 1 and 4 had a cutting speed of 12 feet per minute, and the others cut at 18 feet. The radial and wall drills near the planing machines were of the old type built before the advent of high-speed steel and had feeds and speeds accordingly.

The radial drills in the groups outside had been transformed to a stirrup feed and they were used for reaming punched holes 9/16, 11/16, 13/16, 15/16 inch to sizes ¼ inch larger, with the ordinary style of flat drill in ½- to ¾-inch plates, varying from one ply to eight ply in thickness. The feed averaged 3 inches per minute, though some men could pull 6 inches.

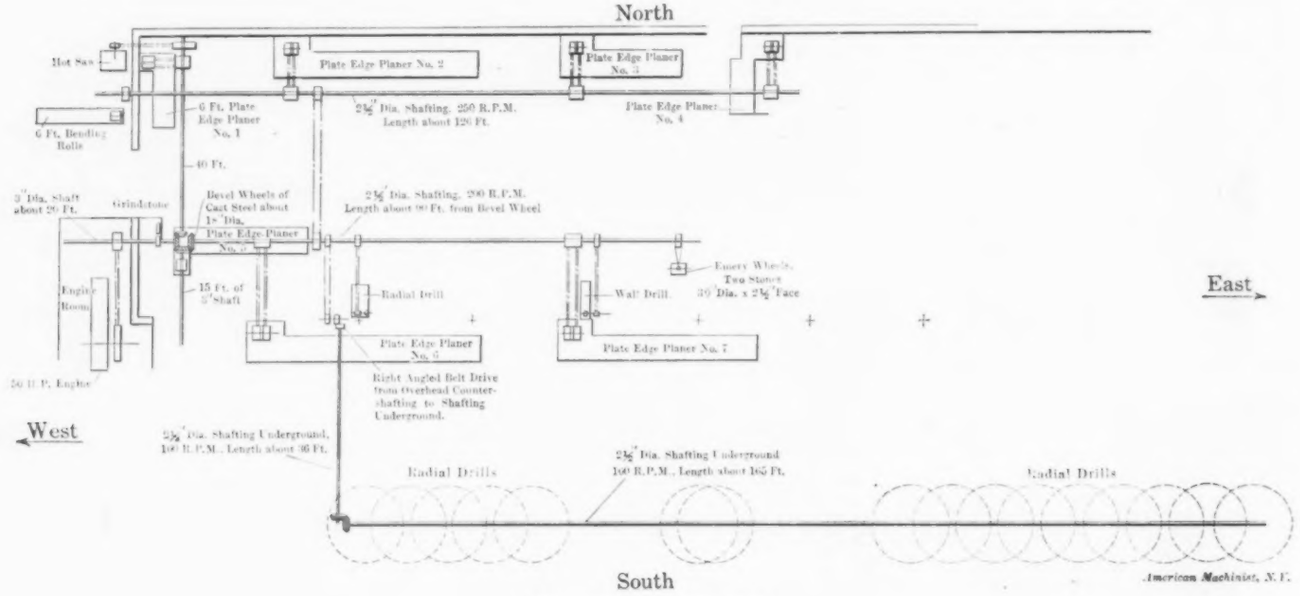
The emery stands had two wheels 30 inches diameter by 2½ inches face, and were used for dressing up the edges of the plates that had been sheared.

The shafting throughout was supported by bearings placed 10 feet apart, and when I examined them the best fit would be ⅛ inch larger than the journal, while many would be a full ¼ inch, owing to wear.

The bending rolls were only used occasionally, perhaps two days per week, and when working did not seem to make any difference to the load.

The hot saw was used for cutting hot angles, such as 4x4x5/8 or ¾ inch, and it used to make its presence felt. Another machine of similar make and doing the same class of work was driven by a 10-horsepower motor, so in all probability the demand of this machine would be about the same, 10 horsepower.

The remaining machine was a grindstone 4 feet diameter by 10 inches face, used for sharpening tools. Some years ago engineers spent a lot of breath over the inefficiency of shafting drives, and in one paper a gentleman was reported to have said that shafting frequently consumed 75 per cent. of the power. It is very difficult to believe that statement in evidence of the foregoing.


North
Hot Saw
Plate Edge Planer No. 2
Plate Edge Planer No. 3
Plate Edge Planer No. 4
6 Ft. Bending Rolls
6 Ft. Plate Edge Planer No. 1
2⅞" Dia. Shafting, 250 R.P.M. Length about 120 Ft.
40 Ft.
3" Dia. Shaft about 20 Ft.
Grindstone
Bevel Wheels of Cast Steel about 15" Dia.
2⅞" Dia. shafting, 200 R.P.M. Length about 90 Ft. from Bevel Wheel
Plate Edge Planer No. 5
Emery Wheels, Two Stones 30" Dia. x 2½" Face
Engine Room
15 Ft. of 3" Shaft
Radial Drill
Wall Drill
East
Plate Edge Planer No. 6
Plate Edge Planer No. 7
50 H. P. Engine
Right Angled Belt Drive from Overhead Countershafting to Shafting Underground.
West
2⅞" Dia. Shafting Underground, 160 R.P.M., Length about 95 Ft.
Radial Drills
2⅞" Dia. Shafting Underground 160 R.P.M., Length about 165 Ft.
Radial Drills
South
American Machinist, N.Y.

THE CURIOUS POWER DRIVE

The shop was improved and the machines moved. A 30-horsepower motor was put where No. 1 machine is shown. It drove a line shaft on the north side from which machines Nos. 2, 3 and 4 obtained their power.

Another 30-horsepower motor drove the remaining planers by means of a line shaft on the south side. A third 30-horsepower motor drove the radials on the outside.

The emery wheels were moved and a 10-horsepower motor was used to drive them direct. The hot saw was supplied with a 12-horsepower motor. The drills, emery wheels and hot saw ran at the same speed as before, but the planing machines Nos. 1 and 4 were speeded to 18 feet per minute, while the other planers were speeded to 24 feet per minute.

Now, a very perplexing feature becomes apparent. The 30-horsepower motors (220 volts) driving the planing machines we soon found were very much overloaded. Here we had before the alteration a 50-horsepower motor driving 7 planers, 16 reamers, 2 drills, 1 hot saw, 1 bending rolls, emery wheels and grindstone, and about 500 feet of shafting, with 6 bevel wheels, supported by 50 bearings.

After the alteration a 30-horsepower motor driving 3 planers; a 30-horsepower motor driving 4 planers; a 30-horsepower motor driving 16 radials; a 10-horsepower motor driving the hot saw, and a 10-horsepower motor driving the emery wheels; total, 110 horsepower, with 365 feet of shafting.

That is double the horsepower and one-third less shafting to do little more than the same amount of work. There was an increase in the amount of work turned out of the shop, but this was due principally to the increased facilities for handling.

I cannot understand why 50 horsepower should have been able to drive all these machines before the reassembling unless the reason is, first, the greater flexibility of the steam engine with the heavy flywheel, and second, that when the machines were all grouped together the peaks of the loads of the various sections were staggered and seldom came together, whereas in the rearrangement the peaks of each group had to be allowed for in each fuse.

Perhaps some of your readers may have had experience with such like and be able to make some suggestions.

It is interesting to note the extent to which the toy industry of the Nurenberg district of Germany amounts. The total value of the output of this district for 1908 was about $4,000,000. The principal products are metal toys of infinite variety, which are mostly cut out by machinery which is often of an ingenious nature and generally operated by females.

Special Machines for Making Comptometers

Force and Punch Presses, Spring Making Machine, Lathe Gage, Riveting Hammer, Grinding Attachment, Multiple Spindle Drill Presses, Etc.

EDITORIAL CORRESPONDENCE

In the manufacture of the adding machine called the comptometer many special machines have been designed and built by the company for the purpose of doing the work accurately and quickly. A great deal of ingenuity has been employed in the making of these machines and with their use the output has been multiplied many times over the methods formerly used. Many of the machines are entirely original in their design and others are a combination of both known principles and original ones.

FIG. 1. SPECIAL PRESS FOR ASSEMBLING COMPTOMETER FRAMES

The machine shown in Fig. 1 is a power-driven press on which the comptometer frames are assembled. The machine is shown just as it has finished a frame, and the frame is ready to be taken out of the machine and put on the rack in the background.

In operating the press, head *A* is raised on the guides *B B*, by the screws and bevel gears that are operated from the line shaft by belt. When the head is raised the finished frame is taken away and the rods *C* are raised up through the plate *D* by their springs. These rods are smaller in diameter than the rods that bind the machine together. The frames are then built up on the rods *C* by taking a side frame, shown in the iron boxes at the lower left-hand corner of the picture, and putting it over the rod. Bushings are then slipped over each rod, and another side frame added; then more bushings and more side frames until the machine is built up to its proper size.

The rods shown at *E* are used to fasten the side frames together, and these are located by placing one, with the end, on top of each rod *C* and the other end under the push rod *F*. The head of the press *A* is then forced down and this drives the rods *D*, which are forced fit in the side frame, into their place.

The number of frames that can be built up for a day's work in this machine is truly remarkable and yet it is a very simple machine that can be operated by a boy.

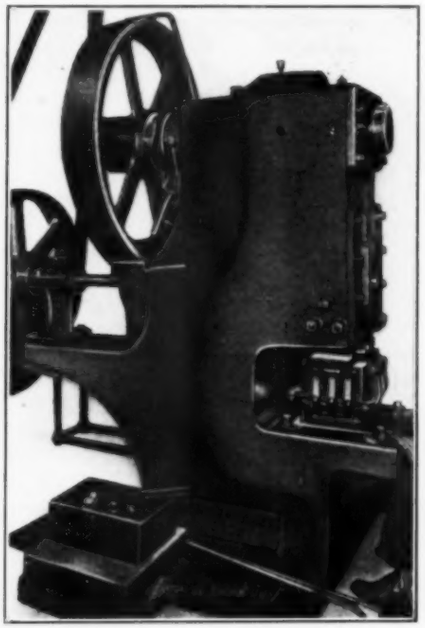


FIG. 2. SPECIAL PUNCH PRESS, WORKING WITH A COMPLICATED SUBPRESS DIE

Special Punch Press and Spring Machine

The punch press shown in Fig. 2 is a special design that was built by the company. As will be noted the side frame is extra heavy and the opening is of a shape and size that will just hold the sub-press die shown in it. A number of these presses are in use as well as some smaller presses for lighter work. The punches and dies, which are used in these presses, are numerous as a large part of the work is punched out and some very fine work is done in this way.

The machine, of which front and rear views are shown in Figs. 3 and 4, was designed for making the spring shown in the

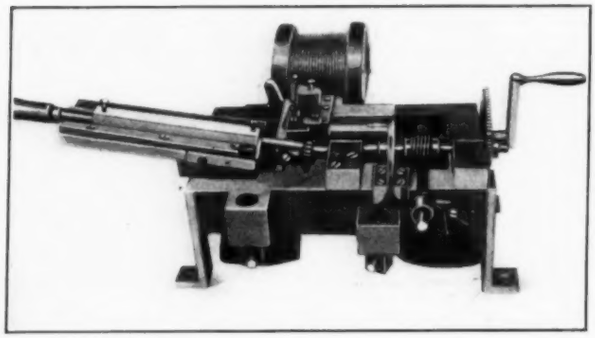


FIG. 3. FRONT VIEW OF SPRING-MAKING MACHINE

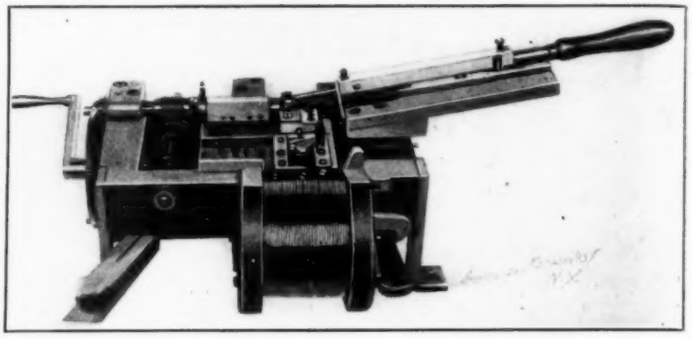


FIG. 4. REAR VIEW OF SPRING-MAKING MACHINE

left of Fig. 5, and also lying on the bench in front of Fig. 3, and on top of the machine, as well as on the bench, in Fig. 4. The spring is very small and, therefore, it is enlarged to 2½ times its actual size in Fig. 5.

The spring is made in three distinct operations: First, the handle, to the left of Fig. 3, is pushed in and this grips the wire and turns the two coils on the end at *A* in Fig. 5. Next, the crank to the right of Fig. 3, is given four revolutions and this coils the body of the spring. The last operation is forming the end of the spring at *B* in Fig. 5, and this is done by pushing in a rod that moves the mechanism to give it the desired shape and also to cut it off.

As will be seen, the springs are made by taking the wire from a spool and a boy can make 2000 a day without any trouble. The spring shown to the right of Fig. 5 is also made on a special machine and is called the carrying spring.

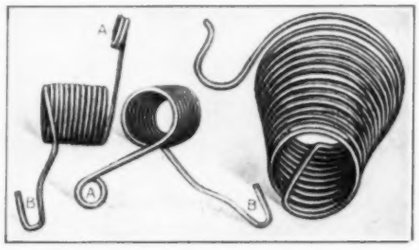


FIG. 5. SPRINGS 2½ TIMES THEIR ACTUAL SIZE

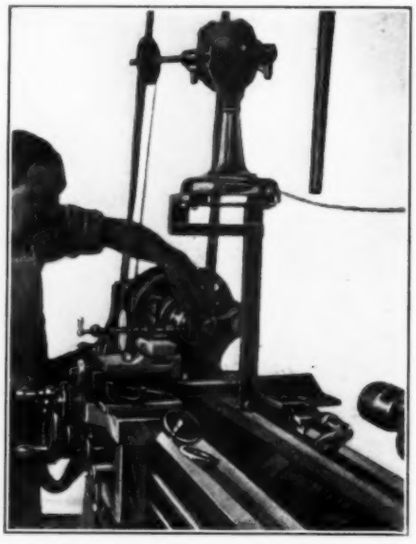


FIG. 7. ELECTRIC FAN DRIVING A SMALL GRINDER ON A LATHE

Lathe Attachments

In Fig. 6 is shown the method of testing the accuracy of the parts as they come from the screw-machine department. In this work all holes and shoulders must be concentric with one another. After considerable experimenting, the company found that the most satisfactory method of testing their accuracy was to put the pieces in the lathe on a hardened and ground arbor and then measure or test it with the indicator, shown on the bed of the machine near the head. This is used on a back-geared Rivett precision lathe and registers to the thousandth of an inch.

A novel attachment for a lathe is shown in Fig. 7. It consists of an electric fan, with the fan removed and a sheave pulley put in its place. This is used for operating the grinding attachment, as shown, for grinding work held in a face plate, on an engine lathe used in the screw-machine department.

On the back side of this lathe will be seen a stop gage. This is made in every detail like a micrometer and the carriage can be easily moved to as fine adjustment as one thousandth of an inch. This makes it possible to do very fine grinding in the lathe, and the stop gage is also useful for making forming cutters for the screw machines.

Riveters and Multiple Spindle Drill Presses

A great deal of riveting is done in the manufacture of the comptometers and the rivets used are very small. For doing this work, special riveting hammers like the one shown in Fig. 8 are built by the company. The hammer is placed on the bench and strikes about 800 blows per minute. It is shown riveting both ends of a piano-wire pin, ten of which are located around

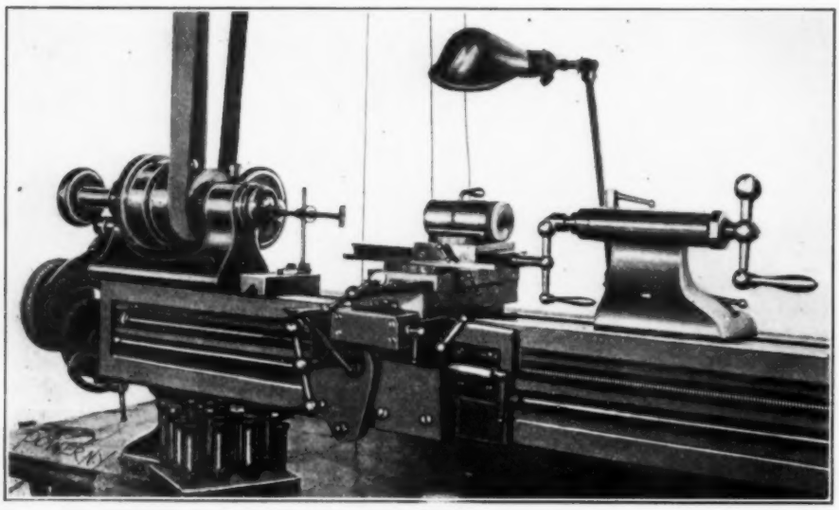


FIG. 6. GAGING WORK HELD IN AN ARBOR IN A LATHE

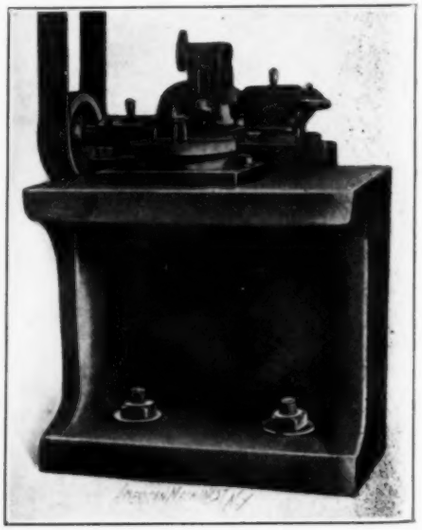


FIG. 8. BENCH HAMMER FOR RIVETING

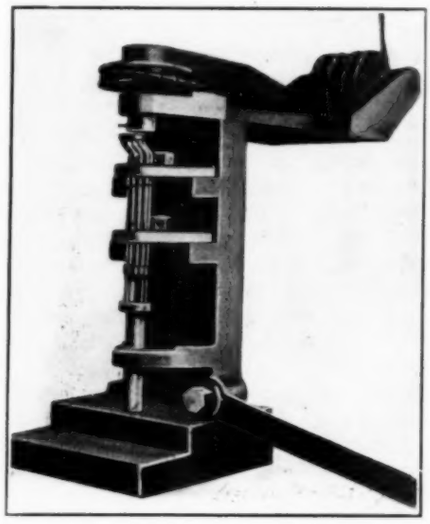


FIG. 9. VERY SMALL 10-SPINDLE MULTIPLE DRILL

the diameter of a piece that is about the size of a ten-cent piece. The ten pins are located in the numerical wheel, which is made from two plates about ⅛ inch apart, and through these the pins pass and are riveted on the outside of each plate.

In Fig. 9 is shown a multiple-spindle drill press that contains ten spindles inside the diameter of a ten-cent piece. This was built by the company and is used for drilling the ten holes in the numeral wheel that is shown being riveted in Fig. 8.

Another drill press is shown, in Fig. 10, that was also built by the company and works on the same principle as that shown in Fig. 9. The ten spindles in this, however, are in a straight line and are used for drilling the holes in the cancelling hook bar. The principle on which these drills operate is plainly seen and with them a much larger output can be obtained than with the old method of drilling one hole at a time. The drill breakage is too slight to speak of.

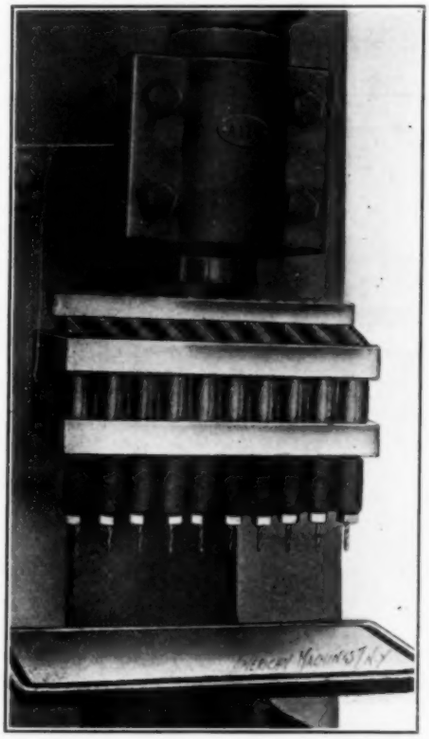


FIG. 10. DRILL WITH 10 SPINDLES IN STRAIGHT LINE

Exercising Machines

One of the principal things in the manufacture of the comptometer is to see that each key works quickly and freely and that all of the parts work in unison. For that reason after the machines are completed they are sent to the exercising machine, one of which is shown in Fig. 11, where they are operated for several hours and then looked over thoroughly to see that each part performs its function properly. These exercises are run at 120 revolutions per minute, thus each key is given 7200 complete strokes each hour.

FIG. 11. COMPTOMETER EXERCISING MACHINE

Another use to which the exerciser is put is that of testing the life of a machine and comptometers have been returned to the company for repairs that have been put in these exercisers and run steadily at 120 revolutions per minute for ten hours each working day for over two years. When one considers the delicacy of the numerous parts in the machine it is remarkable to think that one could be run that long without breaking down in some of its parts.

Automatic Electric Elevator

One of the features of the shop equipment is the automatic electric elevator shown in Fig. 12. This elevator serves four floors, the top floor of which is shown in order to show the operating mechanism that is over the elevator box. The entire elevator is inclosed in sheet steel and it can be started either up or down by pressing a button. A speaking tube is also used in connection with it and one ring of the bell means "hello;" two rings mean the elevator is being used; and three rings means that the car is empty.

By opening the door on any of the floors the switch is thrown off and the car stopped. This prevents accidents, as it is impossible for anyone to get inside of the elevator box while the car is running. It also does away with an elevator attendant, as anyone on either of the four floors can operate the car when the doors are closed and it is not in use.

This elevator is manufactured by the Burdette-Rowntree Manufacturing Company, Chicago and New York.

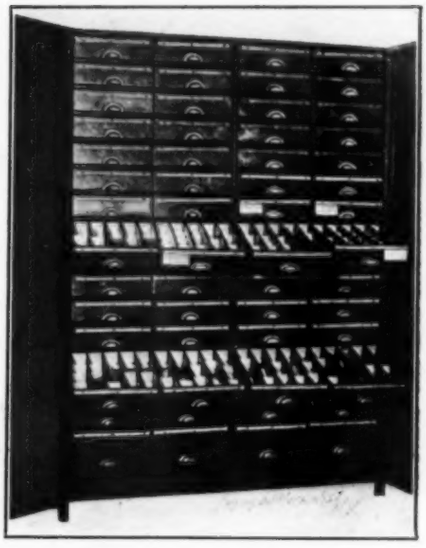


FIG. 13. MASTER SAMPLE CUPBOARD

Sample Cupboard

The master sample cupboard shown in Fig. 13 is an institution in itself. This cupboard is made entirely of steel as is

FIG. 12. AUTOMATIC ELECTRIC ELEVATOR

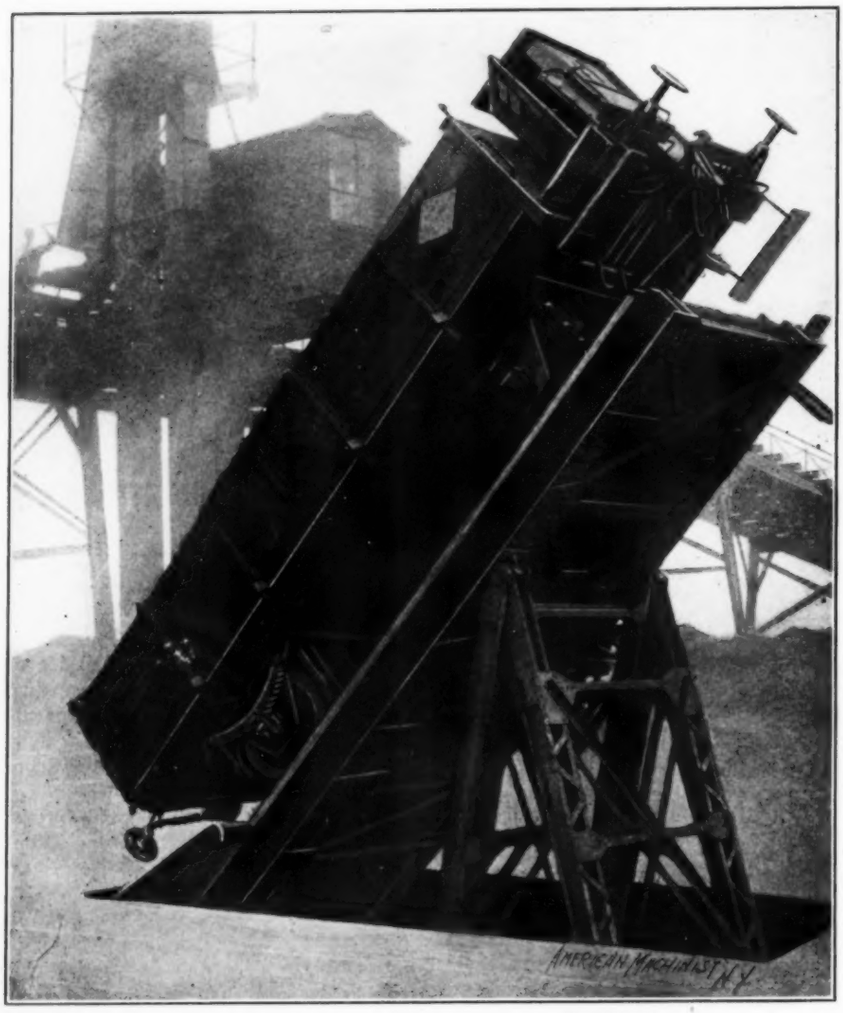


FIG. 1. A GERMAN CAR DUMPER

also all the shop furniture, benches, chairs, etc. It is the superintendent's idea of taking care of master parts and it has proved its value many times over.

The cupboard is taken care of by the chief inspector who here keeps samples of all the pieces that go into a comptometer under lock and key. The samples are used as patterns to manufacture the different parts by and they are not allowed to leave the cupboard without the inspector's consent. He then makes a card record of where they go and when returned a record is also made of their return. Each sample has a private mark, which makes it impossible to substitute anything else in its stead.

These machines, together with the gages which were shown in a previous article, show the accuracy and skill with which the different parts of the comptometer are made and also the way the different parts must act in unison. It is necessary to be accurate in the making of the different parts owing to the fact that it must be made impossible for the machine to make mistakes.

A German Car Dumper

FRANK C. PERKINS

The accompanying illustrations show a car-dumping machine built in Germany. As seen in Fig. 2, the car which is to be dumped stands upon a track platform which rolls on wheels at the dumping end and is raised at the opposite end by means of a pair of struts which are drawn together somewhat in the shape of the letter A, by means of a long screw-threaded shaft. This shaft is driven by an electric motor.

The car is held in position on the dumping platform by a pair of hooks which grip the axles, and the machine will handle cars having a capacity up to 20 tons, and a wheel base of 4½ meters. It is said that the machine will dump from 15 to 20 cars per hour.

The patent office issued 33,514 patents during 1908, reissued 168 patents and registered 6029 trade-marks, labels and prints. There were 22,328 patents which expired during the year. The total receipts were $1,896,848 and the expenditures $1,712,303.

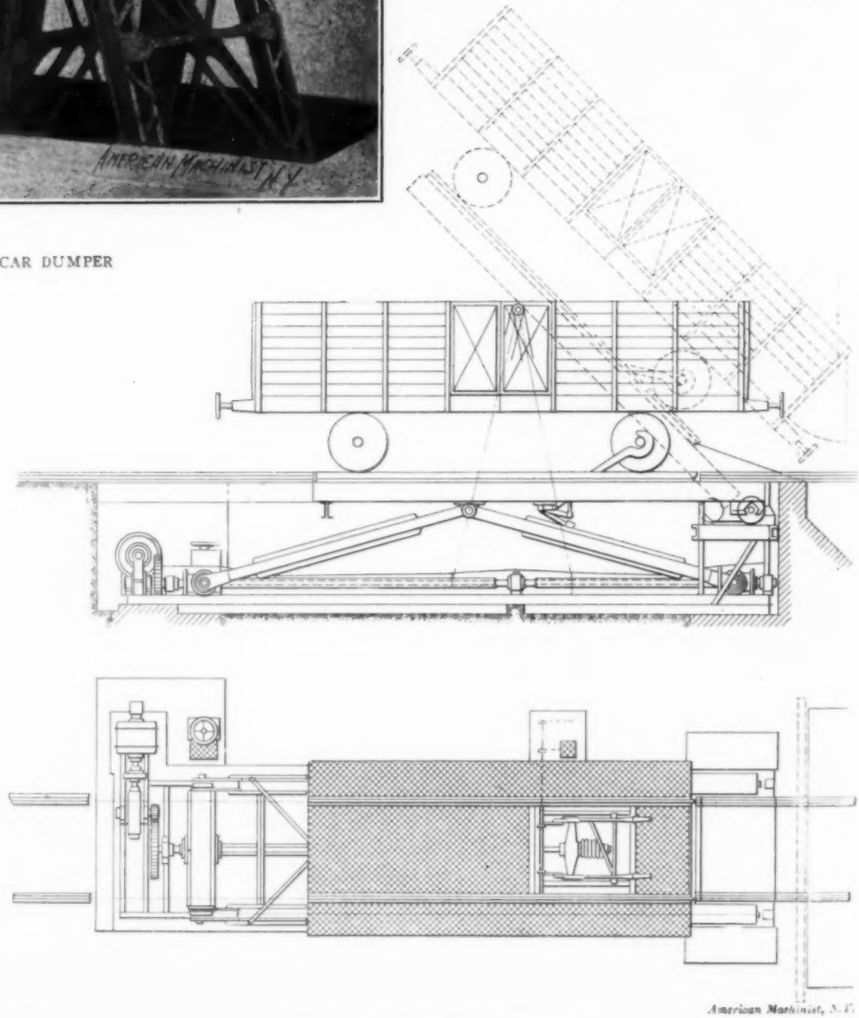


FIG. 2. CAR DUMPER MECHANISM

Can the Power Used by a Centrifugal Pump be Figured from the Water Delivered?

By W. Osborne

They were using the engine to pump water out of the ground. It was a centrifugal pump that the engine was driving, one of these fellows that takes the water in at one side and discharges it at the other. This arrangement bends the water more than is good for the economy of operation but it saves making a hole very much larger than the pump and this is quite a consideration, as it still takes a hole 30 inches in diameter to let in a 24-inch pump which has to go 40 feet into the ground.

This pump must deliver 1000 gallons of water a minute at least and 1200 gallons could be used to good advantage. Under standard conditions the water stood in the well close up to the pump and it was thought that, with the pump throwing the desired amount of water, it never got more than 20 feet lower than the pump. Allowing the total head to be sixty feet and the quantity to be a thousand gallons a minute there would be a little more than 15 horsepower of water delivered, and to this would have to be added the power used up by the pump and by the friction of the water in the pipes.

The engine was rated at 30 horsepower but was run at a speed at which it tested up in the shop better than 44 horsepower on the brake.

"Send a man at once. Your engine is not able to do the work. It hasn't any power. We are only getting 600 gallons a minute with a total head of 60 feet." Surely something must be wrong for that only figured 9+ horsepower of water and it could not be possible that the pump and water friction ate up the balance. Either those people did not know how to run the engine or else they did not know how to measure the water.

The best man available was sent. He did not know much about centrifugal pumps but he did know the engine from start to finish.

This outfit was so far from the shop that the man had to act for himself and this he did. First he did everything that he could to make the engine pull its utmost. After he had done his best the amount of water that the pump would deliver was not satisfactory. He was certain that the engine was doing a fair amount beyond its rated horsepower but he could not understand why it was that the pump did not throw more water.

One of the things that he observed that was very curious, at least to him, was that the pump delivered less water at times when the engine was working the hardest. At times the water came in a fairly satisfactory volume and the engine ran nicely and carried the load and then the load would increase so that the speed of the pump could not be maintained. With this increase in load would come a decrease in the amount of water delivered.

To be sure that the water in the well was not being lowered so that it was below the end of the suction pipe, the pump was raised from the pit and enough additional suction pipe put on to reach down to about 40 feet below the pump.

This did not seem to better matters any.

As a business transaction the matter was arranged harmoniously. The parties using the pumps arranged for more power. As to making the behavior of that pump harmonize with the theoretical knowledge possessed by the man who went to the pump, or with that possessed by his shopmates, no satisfactory conclusions have ever been reached.

To begin with they do not know much about centrifugal pumps, and what little they have been able to find published on

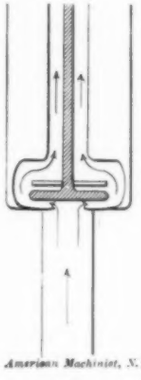


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DIAGRAM OF COURSE OF WATER THROUGH A CENTRIFUGAL PUMP

the subject has not helped much. The centrifugal pumps the books tell about have not a near enough likeness to the one under consideration to make it safe reasoning from one to the other.

The accompanying diagram sketch will show the course of the water in the pump.

In trying to get a grip on the actual state of affairs under the conditions a number of questions have come up that need answers with more information back of them. Here are some of them.

Some Questions

When running at a constant speed under what condition of water supply will the power consumed be greatest?

Is it possible, with this kind of a pump, to figure the power being used from the speed of the pump and the amount of the water being delivered?

It is evident that if the water supply was not large enough to keep the pump fully supplied the pump would have to suck in trying to get it. With the water rising up so as to submerge the pump there would not be any suction and even under the most extreme conditions this suction could never be more than 15 pounds, and would not be likely to be anywhere near to that under working conditions. If a cock were placed in the suction line so that the supply of water could be controlled at will, what would be the effect of slowly closing this cock?

With an adequate water supply it is evident that the most water would be delivered when the cock was wide open, and from that it would decrease until there would not be any delivered when the cock was entirely closed. It is assumed that the pump is kept running at a constant speed. Would it take more power to drive the pump with the cock wide open than it would to drive it with the cock entirely shut, or would the reverse be the case, or would the greatest power be required at some intermediate point?

If it takes more power to drive the pump with the cock closed, would this increase in power be more than would be equivalent to an increase in head on the discharge side of 34 feet?

It is certain that the efficiency of this style of a pump is low, and this must be due to three things; the friction of the pump, the friction of the moving water, and the loss due to bending the water so much out of a straight line. From this it would seem that when the suction was entirely closed, two of these losses would be eliminated and the amount of power necessary to keep the pump going should be decreased just as it is when the discharge of a fan blower is closed.

Effect of Operating a Valve in the Discharge Pipe

While there is not any information at hand to show what would happen with a valve placed in the suction pipe, there is some to show what would take place with one placed in the discharge pipe.

The pump was run with an electric motor which was belted to the pump. It took over 9¼ horsepower to run the motor and the pump up to speed without any water in the pump.

The valve in the discharge line was a straightway gate valve. With the valve wide open and the pump running at 615 revolutions per minute the gage showed a head of 34 feet and the wier showed a delivery of 2150 gallons per minute. The total power delivered to the motor was 53.7 horsepower, which is about three times the theoretical power necessary to raise that quantity of water through that distance.

With the valve closed until the pressure represented a head of 50 feet the flow of water decreased to 1180 gallons per minute and the power to 45.1 horsepower.

With the valve closed until the pressure represented a head of 70 feet the flow of water was 410 gallons per minute, and the power was 35.4 horsepower.

It will be seen from these figures that the 30-horsepower engine could not possibly pump 1000 gallons per minute against a head of 60 feet. A test with a

head of 64 feet gave a delivery of 640 gallons of water with a power of 38.2 horsepower.

Unfortunately there is no information at hand to show how much increase in speed and power it would take to increase the delivery of this last test up to 1000 gallons per minute with the head remaining the same.

It seems reasonable to suppose that there is a limit to the amount of water that a well will supply (the water in the tests referred to above was taken from a tank), and that when that limit is reached a further increase of speed will not have any effect in increasing the supply. If this is true then an increase in speed will not increase the quantity of water delivered by any great amount, but it would be interesting to know what increase of power would be necessary to get increase of speed under such conditions.

There is one other point that the shop man would like a little light on, and that is how he is going to prove to the man who bought the engine that it is what it is sold for when it is "doing its darndest," and yet the pump is only delivering 7¼ horsepower of water as it did in the test with a 70-foot head for instance?

It took 45.1 horsepower to deliver 1180 gallons of water against a 50-foot head as against 53.7 horsepower to deliver 2150 gallons against a 34-foot head.

There was an increase of head of 47 per cent., with a decrease of water delivered of 45 per cent. and a decrease in power of 16 per cent.

Comparing the 70-foot lift with the 34-foot one there was an increase of head of 106 per cent., a decrease of water delivered of 81 per cent, and a decrease in power of 34.2 per cent.

Perhaps others may have tests of such pumps that will settle some of these questions.

Roller Belt Shippers on Planers

By Herbert E. Potter

On examining the shippers on all of our planers, they showed considerable wear, due to the friction of the belt; in some cases quite deep grooves were worn in the cast-iron shippers. To overcome this, we changed over our belt forks, cutting off the original shipping arms and securing a bracket carrying two rollers, so the edge of the belt ran against the rollers instead of against the stationary arms used on most all planers.

The roller studs were drilled to form oil chambers for lubricating the rollers. These have been running some time and are giving satisfaction and in overcoming the friction to a considerable extent, we shall, no doubt, prolong the lives of expensive belts enough to recompense us for the small outlay incurred.

The Entropy System for Paying Labor

By Entropy

Among the things that are usually wrong that Professor Sweet has not yet touched upon is the method of paying for work. Time was, when practically all work was done by the day, which meant that if the end of the job was in sight, or the workman thought it was, he would become a "soldier," which is only another way of saying that a man is paid for time only.

Now a man on day pay can only be made to do a day's work by leading or driving. If he is afraid he will lose his job he will speed up to hold it, but only to the limit fixed by his idea of what will hold it. Paying a man for his time may be all right in a few cases, but with nine out of ten men a day's work under such conditions is only so much work as he has schooled himself to believe ought to be accepted. His conception of a day's work is largely based on what he sees other people doing, consequently it is more apt than not to be rather limited. Paying men by the day leads to profitable business many times, but usually it is profitable only when the real profit is an engineering one and earned by the owner.

All of us know of shops that make money, yet are run in the most slip-shod manner, but where the proprietor is a man of reputation enough as a designer so that he gets fancy prices for his work. Such shops would do well to shut down and contract out their work. They would make more money.

The Piece-work System and How It Works

Then there is the piece-work system. What is more natural if you have ten acres of potatoes to be dug than to hire a man to dig them at so much a bushel? And what is more natural than that the man who digs at a piece rate should dig twice as many in a day as he would on day wages? And then what is more natural than that the "boss" should see that his potato digger was making too much money, etc. And on the other hand why should not he cut the rate? Why should not he put the various jobs up at auction between his men or invite bids? A job is worth just what a willing bidder is willing to do it for. Circumstances may make it desirable or necessary that a certain man should have work to do at a certain time. He could afford to bid low for the sake of being busy until one of his soft jobs came along. A soft job to him would be one that he knew how to do better and quicker than any other man in the shop. The best man in the shop would prove what a few employees have always known, that he was the cheapest, he would get the cream of the jobs at the lowest figures and make the most money.

The Entropy System of Paying for Labor

Now the Entropy system of payment is simply this. Engage your men at any reasonable day rate and guarantee them that rate. Keep posted a list of jobs which are coming along. Let every man in the shop have cards on which is a printed form which he can fill out with the price per piece of finished accepted work which he wishes to bid and the guaranteed delivery. On the card print the penalty for late delivery, a certain percentage of the price bid. Let every man that wishes bid on all jobs on the list. When the job is done let the man who secured the work make out another card which is really a bill, let it be O. K.'d by the inspector and passed up to the office to be paid like any other bill.

Some men will cut rates to hog the work and get caught on the time guarantee and then quit. Others will pick for the good jobs and ocasionally have a few days' rest. Others will strike a happy medium and average to make about the wage that satisfies their idea of how hard they want to work and how much money they want. Some will kill themselves working; others will starve themselves loafing. Either one probably will learn a lesson in finance that will be valuable. Human nature being what it is, the average rate of work will be such as to make each man's pay about double the going rate for day wages and the work turned out in a given time enough more to satisfy any employer who is not a hog.

Of course, when the boss finds that all the men in the shop are bidding the same price on the same job, he will smell out a combination in restraint of trade and apply to the Interstate Commerce Commission or the Hague Tribunal for relief. Or he may employ new blood or hire an expert to set the pace. If the latest apprentice boy offers a bid for some work on the boring mill it would have to be rejected unless he would file a bond equal to the value of the work and the tool; but if the privilege of rejecting any or all bids is reserved there should be no trouble about that. Someone will say that they do not want their employees wasting time figuring on jobs, but under this system all the time belongs to the men and it is unlikely that they will waste much time while the shafting is running figuring up their bids.

If the Entropy system of paying labor is all wrong, then we ought to have the purchasing public set the prices which they will pay for all the machinery which they will buy, and we ought to reform the whole buying system of the world to conform with our antique notions of settling with our help.

Indicating a Compressor Discharge Pipe

Some Peculiar Wave Motion Diagrams and How They Can Be Used to Determine the Economic Performance of an Air or Gas Compressor

BY SNOWDEN B. REDFIELD

A great many questions have been asked as to what causes the wide variation in the pressure delivered by an air compressor as shown by the very wavy line of discharge on the indicator card. The only explanation for these irregular lines lies in possible pulsation in the air as it is forced out of the compressing cylinder.

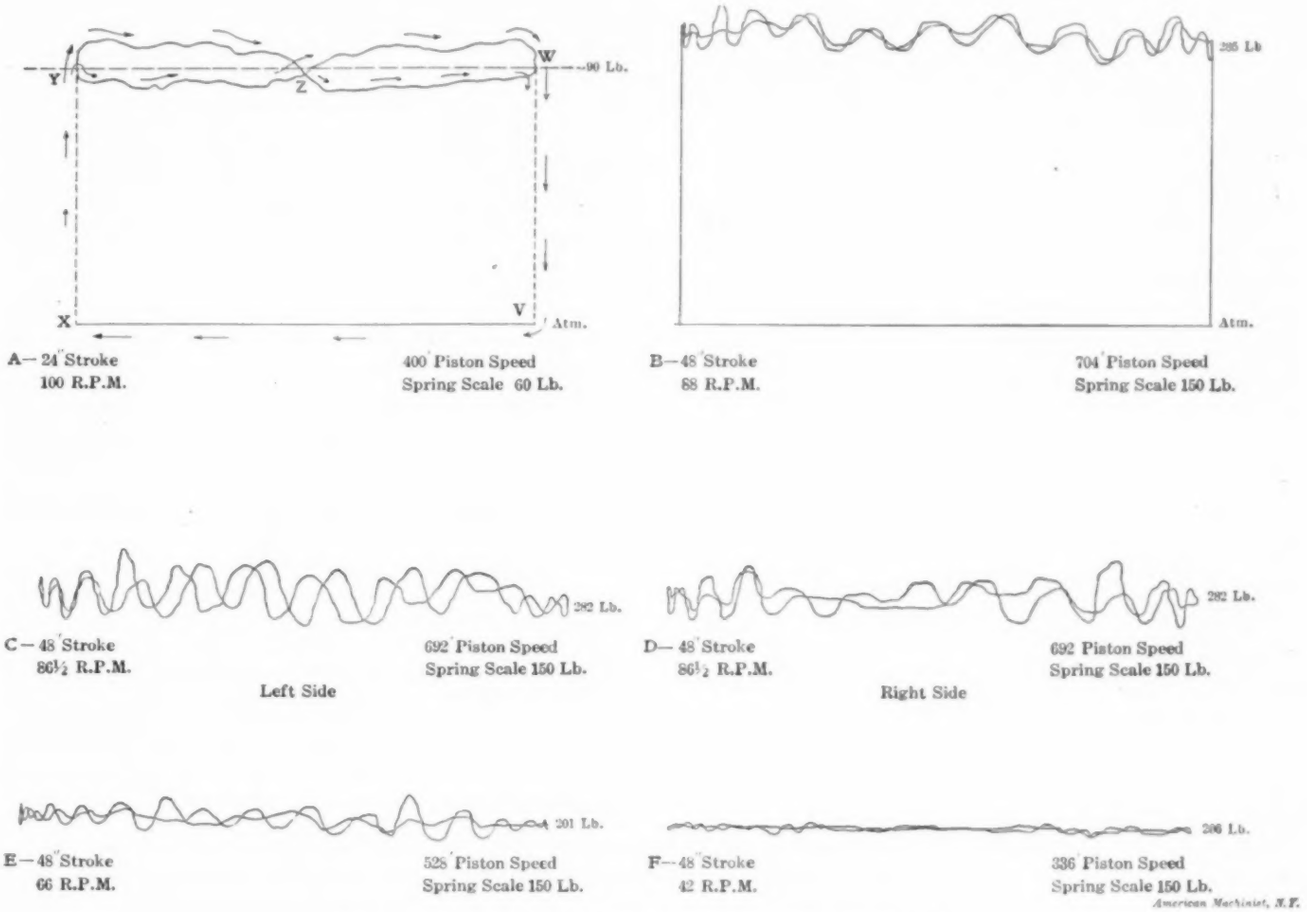
These pulsations are not always alike, or it should be said are seldom alike, although under given conditions an indicator card from the same compressing cylinder will really show exactly the same wavy lines. Sometimes these pulsations appear to be very much more violent than at other times, and it is found that the higher the speed and the smaller the valve area provided in the compressor, the more amplitude there is to the waves shown on the discharge line of the indicator card. At very slow speeds the vibrations can be almost eliminated with indicator springs of the usual stiffness.

Another way of studying these interesting pulsations in the air pipe leading from an air compressor is to take an indicator diagram from the discharge pipe itself by attaching an indicator to the side of the pipe close to the air cylinder, or wherever it is desired to study the pulsations in the pipe.

It is a curious thing that the figures obtained in this way are always the same as long as the conditions of speed and pressure are unchanged for any particular compressor and position in the discharge pipe, and no matter how violent these vibrations may be, due to high speed, the indicator pencil will go right on over the same lines of the complicated figure produced as long as may be desired. One would think that the pulsations would change from instant to instant when the figure becomes very irregular, and that the diagram produced by continuing to allow the pencil to trace upon the indicator card would finally become nothing but a snarl of lines.

The Diagrams

In Fig. 1 there are reproduced several different diagrams obtained from compressor discharge pipes. In this figure there is shown at *A* an ordinary pipe diagram with moderate speed and moderate pressure. This diagram, as might be predicted, takes the form of an elongated Fig. 8, the high parts corresponding to the period of discharge of first one end of the cylinder and then the other, while the low parts are produced during the interval when no air is being forced into the pipe from the compressor; that is, during that part of the compression stroke before the pressure in the cylinder has reached that of the discharge. All of the other diagrams given in this figure were taken from a compressor pumping natural gas. The various pressures and speeds are



A—24" Stroke, 100 R.P.M. 400' Piston Speed, Spring Scale 60 Lb.

B—48" Stroke, 88 R.P.M. 704' Piston Speed, Spring Scale 150 Lb.

C—48" Stroke, 86½ R.P.M. 692' Piston Speed, Spring Scale 150 Lb. Left Side

D—48" Stroke, 86½ R.P.M. 692 Piston Speed, Spring Scale 150 Lb. Right Side

E—48" Stroke, 66 R.P.M. 528' Piston Speed, Spring Scale 150 Lb.

F—48" Stroke, 42 R.P.M. 336' Piston Speed, Spring Scale 150 Lb.

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FIG. 1. INDICATOR CARDS TAKEN FROM A COMPRESSOR DISCHARGE

marked on these several figures and it will be seen that for each pressure and each speed there is a distinct diagram for any one cylinder, although, as said, each diagram can be reproduced from a given pipe any number of times as long as the speed of the compressor and the discharge pressure are kept constant.

As shown in the figure, as the speed decreases the diagram becomes of less and less amplitude, so that at *F*, the lowest speed, it is almost a straight line. At *F* the piston speed is only a little less than at *A*, but it is seen that the diagrams are widely different. This difference is due to two things; first, the scale of the spring in the two cases is entirely different, being 60 pounds per inch at *A* and 150 pounds at *F*. This stiff spring, of course, causes the pulsations to appear of small amplitude although the actual pressure variations may be as great in the case of *F* as of *A*, but *F* is comparable only with *B*, *C*, *D* and *E*, taken with a 150-pound spring and these correctly show the relative effect of speed change under otherwise similar conditions.

The Practical Use

These diagrams may be very curious to look at, but the question naturally arises what are they good for? As a matter of fact, these diagrams may be made to serve a very useful purpose; that is, to determine absolutely what is known as the efficiency of compression of the compressor. The efficiency of compression is the ratio of the theoretical power required to compress a given quantity of air or gas from any one pressure to another, to the actual power required to be developed in the compressing cylinder. If the efficiency of compression is low, it means that the compressor is doing more work than is necessary, and there is a loss somewhere in the cycle of compression.

The efficiency of compression depends entirely for given conditions of pressure and speed upon the valve area of the compressing cylinder, and consequently is a factor which may be improved by first-class construction. In buying an air compressor, therefore, it is very advisable to find out beforehand what guarantee as to efficiency of compression will be made by the manufacturer. The purchaser almost always asks what volumetric efficiency will be obtained, but the efficiency of compression is usually allowed to remain quietly in the background, and most of the compressor manufacturers are very willing to have it stay out of sight.

Of course the theoretical power for any given pressure conditions may be figured either by the adiabatic or the isothermal formula, or in fact for any other compression curve. The isothermal is the best that can be hoped for, although never attained with an air compressor, but the adiabatic is very much more nearly equal to what is actually obtained from ordinary compressor practice. It makes no difference which figure is used for comparison as long as it is clearly understood which efficiency (that is, the isothermal or adiabatic) is intended.

The Efficiency of Compression

As an example of efficiency of compression referred to the adiabatic, we may take the indicator card shown in Fig. 2. This card was also taken from a natural gas compressor and, as is usually the case with natural gas, the intake pressure was very considerably above the atmosphere. In this particular case the intake pressure to the compressor was 51½ pounds gage, and the gas was then compressed up to 281 pounds, the actual discharge pressure measured in the pipe. Now the theoretical adiabatic power required to compress 100 cubic feet of natural gas from 51½ pounds to 281 pounds at sea level is 49.9 indicated horsepower per 100 cubic feet of gas actually compressed and delivered per minute.

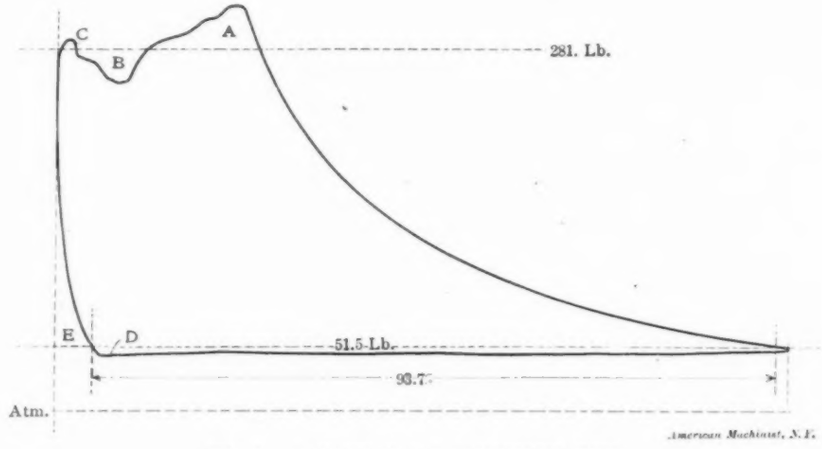


FIG. 2. A NATURAL-GAS COMPRESSOR CARD

By going over the indicator card shown in Fig. 2 it is found that the mean effective pressure developed in this cylinder is 112½ pounds per square inch. This mean effective pressure corresponds to 49.2 indicated horsepower per 100 cubic feet of piston displacement of the compressor. There is, however, another factor which enters here; that is the volumetric efficiency. If 100 cubic feet of piston displacement of the compressor actually delivered 100 cubic feet of gas measured at the intake pressure, this would be the horsepower per 100 cubic feet, but in this case the volumetric efficiency is 93.7 per cent., or in other words there are 93.7 cubic feet of gas actually compressed and delivered for every 100 cubic feet of piston displacement of the compressor. It is, therefore, necessary to divide our figure 49.2 by 0.937, giving an answer of 52.4 indicated horsepower actually developed in the compressing cylinder per 100 cubic feet of gas actually compressed and delivered from the cylinder per minute, measured at the intake pressure of 51½ pounds per square inch.

Now, as already said, the theoretical adiabatic power required for compressing natural gas from 51½ to 281 pounds is 49.9 indicated horsepower per 100 cubic feet per minute and, therefore, the efficiency of compression will be the ratio of 49.9 to 52.4, or 95.3 per cent. In other words, although as in all good compression work, the compression curve falls below the adiabatic compression line, the excess area of the indicator card as shown above the discharge line at *A* and *C* in Fig. 2 and also the area underneath the intake line at *D* in the same figure, do actually make the indicator card greater in area than it would be if the compression line followed the true adiabatic line and were cut off square at the top along the discharge line and at the bottom along the intake line. The areas *A* and *C*, as said, tend to increase the area of the card, whereas the area *B*, which is due to a pulsation of the pressure in the pipe line, and the area *E*, which is due to re-expansion from the clearance space, both tend to decrease the area of the indicator card and bring it down more nearly equal to the theoretical power required.

In this connection it may be noted that the volumetric efficiency, while it means a decrease in the quantity of gas delivered by a machine of a given size, also means a decrease in the power required to compress this gas by an amount equal to the area *E* shown in the card, and this reduction in area is almost exactly the same as the reduction in the quantity of gas compressed, so that loss of volumetric efficiency means very little loss of power efficiency.

The compression efficiency shown by this particular card is very good indeed, as it is no unusual thing to find this efficiency for some of the poorer grades of compressors as low as 85 per cent. As said, this efficiency depends upon the valve area and speed of the compressor, and it

s also very materially affected by the ratio of compression; that is, the absolute discharge pressure divided by the absolute intake pressure, or the number of times that the pressure is increased in the process of compression. The higher the ratio of compression the higher the efficiency of compression, because as the useful power increases, the area of lost work shown on the indicator card bears a smaller ratio to the whole. It is, therefore, important that the efficiency of compression for different compressors should be carefully compared under the same conditions of compression ratio, and also compressor speed.

This is all very well, but what does this have to do with the pulsation diagrams shown as taken from the compressor-discharge pipe? It is just this: The efficiency of compression can be calculated only when the actual discharge pressure is known, and it very seldom happens in a compressor station that the pressure gage reads anywhere near the correct figure. Its error may be anywhere from 1 to 10 pounds, or even more, and it is also usually piped up at such a great distance from the compressor that the reading, even if the gage is carefully calibrated, is not the true discharge pressure of the compressor at the discharge pipe where the compressing cylinder delivers the air or gas.

If, in order to eliminate these losses of pressure drop in the pipe line after the gas or air has left the compressor cylinder, which losses should not be charged against the compressor, the pressure gage is placed on the discharge pipe close up to the cylinder, the pulsations of the gage hand caused by the air pulsations, which we have said so much about already, will make it impossible to get an accurate reading of the true discharge pressure, even if the gage itself is accurate. The only thoroughly satisfactory way to obtain the actual discharge pressure for careful calculation is to put an indicator upon the discharge pipe, as already described, and to take these diagrams of the pulsations in the pipe.

It must be understood that the indicator must be positively driven from the compressor mechanism just as the regular indicator on the cylinder is driven in order that a true diagram of the pulsations taking place with each stroke of the compressor may be obtained. If the indicator string is pulled by hand without regard to the motion of the compressing piston, the diagrams obtained will never be twice alike, and moreover it will not form a closed diagram which it should, of course, do. The only proper way to do this is, then, to drive the indicator on the discharge pipe from the same source as the indicators on the cylinder, that is, usually from the crosshead.

Calculating Results

After our diagram of the air pulsations has been obtained, how can we obtain the actual discharge pressure? Turning back to Fig. 1 and looking at diagram *A*, we will see at each end of the atmosphere line, a perpendicular erected. Now using a planimeter and starting in, say at *X*, we can follow up the vertical line until it comes to *Y*. At this point continue farther up with the pointer and follow around the upper line, as shown by the arrows, to *Z*, where the other line is crossed. Continue along the underside of the right-hand end of the figure 8 until you come to *W*, and at this point turn sharply down along the perpendicular leading to the other end of the atmosphere line at *V*, and finally back along the atmosphere line to the point *X* where we started. Let us assume that the area thus obtained is 4.05 square inches.

Again starting at the point *X*, follow up the vertical line to *Y* and at this point turn sharply to the right along the lower side of the left-hand end of the figure 8, coming again to *Z* where the other line is crossed. Following along the upper side of the right-hand end of the figure 8 we come to *W*, and from here we go down the perpendicular to the atmosphere line and finally along the latter to the point *X* from which we started. Let us assume that the area thus obtained will be 4.01 square inches. The average of these two areas is 4.03 square inches.

Measuring the length of the diagram we find it to be 2.69 inches. If the average area of the diagram *X Y W V* is 4.03 square inches and its length is 2.69 inches, the average hight will be 4.03 divided by 2.69, or 1½ inches. If now a line *Y Z W* is drawn 1½ inches above the atmosphere line *X V*, this will truly represent the average pressure shown by the figure 8 curve, which is, of course, the true average pressure in the discharge pipe. If the scale of the spring is 60 pounds to the inch, this line 1½ inches above the atmosphere line will represent 90 pounds pressure.

This gives an accurate means of calculating the theoretical power to the exact pressure at which the air or gas is being delivered from the compressor and, comparing this theoretical power with that actually obtained by an indicator on the compressing cylinder itself, the true efficiency of compression of the machine may be obtained.

For diagrams such as the others shown in Fig. 1, which are somewhat unusual in their extreme number of vibrations, an easy way to obtain the average hight is to traverse the planimeter point along the wavy diagram half-way between the two lines, of course crossing both lines each time the two lines cross each other. This is especially easy where the lines follow each other very closely, as in diagrams *B*, *D*, *E* and *F*. Although this method is not quite so accurate as it would be to follow out each separate wavy line by itself, taking an average of the two areas thus obtained as we did for Fig. *A*, a little practice will develop sufficient skill to obtain results in this way just about as accurate as if each line were followed separately.

This average method cannot be adopted in such a diagram as that shown at *A* because as the lines cross each other at one point only, *Z*, if we are to try to follow the middle line through the figure 8 with the planimeter point, we might as well draw the average pressure line in with a pencil by guessing at it and then measure the distance. Such a procedure, of course, at once destroys all the accuracy that it is desired to obtain by the use of the diagrams and the planimeter instead of the ordinary pressure gage.

This study of the efficiency of compression of various compressors under various conditions of ratio of compression, speed and valve area is exceedingly interesting, and it is a subject well worthy of careful investigation. By this means only can a true estimate be made, with sufficient data at hand, to determine just how much valve area the compressor cylinder should have for a given set of conditions to give a certain efficiency of compression and consequently facilitate the making of accurate guarantees of performance on the part of various manufacturers. Little has been done along these lines, and it is a very fertile field for original research work, giving, as it does, an absolute basis by which one make of compressor may be compared with another in point of power economy.

"A business communication in Arabic reached a Manchester firm," says *The Marine Review*, "and when translated by a Syrian interpreter proved to contain a request for the price for 'two water sheep' of certain given dimensions. The translator was confident of his version, but admitted that he did not know what water sheep could be. For the moment even the principals of the firm to whom the communication was addressed were puzzled, until it struck someone that this was the nearest synonym in the vocabulary of a pastoral people for 'hydraulic rams.'"

The Gunnison tunnel, situated in the western part of Colorado, which the United States Reclamation Service is pushing toward completion, is a notable piece of irrigation engineering, and when finished will be the largest underground waterway in the world. Its cross-section is ten and a half by eleven and a half feet, will be six miles in length, and will cost more than $2,500,000. Cement lined throughout it is designed to carry 1300 cubic feet of water per second. Progress with its construction is meeting all anticipations, the two headings having recently been joined, and when in full commission the great tunnel is expected to make an enviable record in the annals of irrigation history.

The Telautograph in the Machine Shop

By A. L. Pratt

The telautograph, the instrument for reproducing handwriting at a distance, is well known, but is not commonly looked upon as a possible feature of machine-shop equipment. Yet the Stanley Flagg Company, at Pottstown, Penn., has an outfit of three sets of instruments connecting the shipping room with the machine shop and shipping clerk. A set of instruments consists of the sender and the receiver. The halftone illustration, Fig. 1, shows instruments of the type in use by the Flagg company, although not the particular instruments as made by the Gray Telautograph Company, New York, N. Y.

By means of this installation the shipping clerk can ask questions of the machine shop in regard to parts for shipment, request promise of dates of shipment, hurry neglected orders, and, in fact, be in close touch with the entire shop production.

The advantages over the telephone are two: A request of any kind is made in writing, of which the original is with the sender and the reproduction by the machine with the person who receives. Thus, there can be no question as to whether or not the message has been sent and received. Such questions frequently arise in connection with telephone messages. Again, the written request serves as a memorandum which the one receiving can keep in any convenient place until the matter mentioned has been duly attended to, and a reference to his own sending file shows whether or not it has been answered and the nature of the answer.

The system seems almost ideal as a means to trace work through the shop, get definite promises of shipment, and check the keeping of these promises.

Specimen Records

Fig. 2 shows a reproduction of, first, a section of a sending roll of paper from the shipping office with numerous questions, and second, a similar section of a sending roll from the machine shop, showing typical answers to questions asked in regard to time of delivery, etc. Another valuable point in this system is in the fact that there is no waiting to get a connection with the person who is to receive the message. If that person is absent from his desk the message is sent just the same and awaits his coming. Compare this with the use of the telephone.

Another Industrial Use of the Telautograph

Another use for the telautograph in manufacturing has been found in connection with the rolling mills of steel plants. One such installation is at the South Side plant of Jones & Laughlin, Pittsburg, Penn. The points connected are the soak-

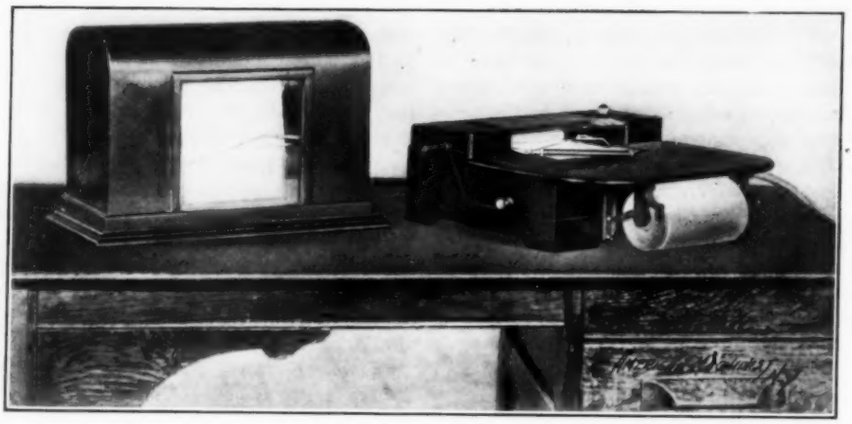
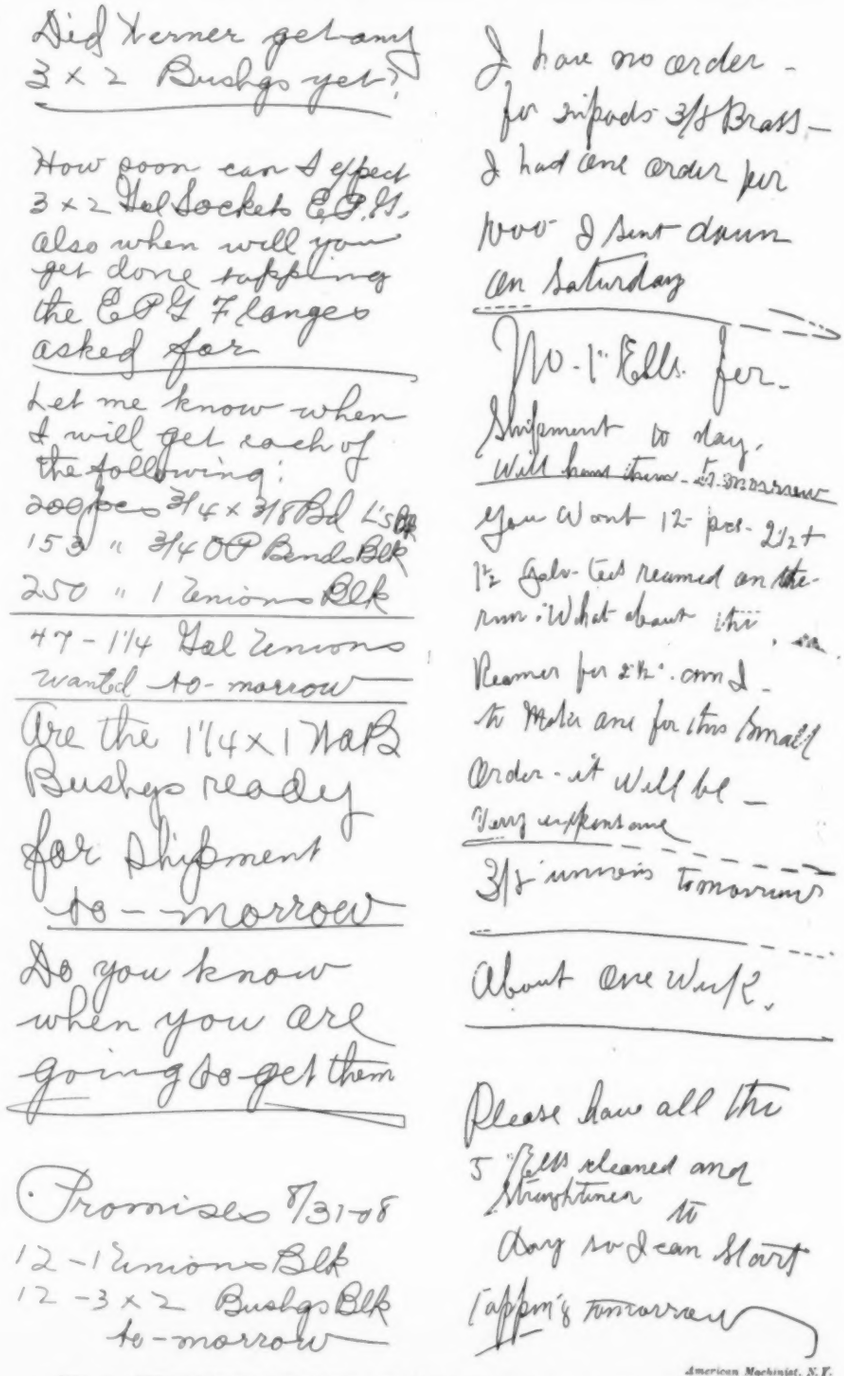


FIG. 1. A SET OF TELAUTOGRAPH INSTRUMENTS AS USED IN A MACHINE SHOP


Did Werner get any 3 x 2 Bushgs yet?
How soon can I effect 3 x 2 Hd Sockets C.P.G.
also when will you get done tapping the C.P.G. Flanges asked for
Let me know when I will get each of the following:
200 pcs 3/4 x 3/8 Bd L's
153 " 3/4 OP Bend Blk
250 " 1 Unions Blk
47 - 1 1/4 Gal Unions wanted to-morrow
Are the 1 1/4 x 1 Nat'l Bushgs ready for shipment to-morrow
Do you know when you are going to get them
Promises 8/31-08
12 - 1 Unions Blk
12 - 3 x 2 Bushgs Blk
to-morrow
I have no order - for nipples 3/8 Brass - I had one order per 900 I sent down on Saturday
No. 1" Ells for - Shipment to day. Will have them - to-morrow
You Want 12 pcs. 2 1/2 + 1 1/2 Galv. Tees reamed on the run. What about this, as Reamer for 2 1/2". cannot - to Motor and for this small order - it will be - Very expensive
3/4" unions tomorrow
About one Wk?
Please have all the 5" Ells cleaned and Straightened to day so I can Start Tapping tomorrow

American Machinist, N.Y.

FIG. 2. REPRODUCTION—REDUCED—OF MESSAGES SENT BY THE TELAUTOGRAPH

ing pits, 28-inch billet mill, billet-mill stamp, billet-mill hot bed, and 28-inch billet-mill shears. The nature of the service is as follows:

As each billet is drawn from the soaking pits, it is carried by crane to the 28-inch billet mill. The operator at the soaking pits sends over the two-way line the data relating to the billet as follows: Number of billet, kind of steel, quality, or intended use, heat number, and number of pit from which it is drawn. A single line of writing suffices for all of this information. For example, 6 — Bess. RB-21,560-R-1, which means billet No. 6, bessemer steel, red billet, heat No. 21,560, from pit No. 1.

The operator of the 28-inch billet mill checks off each line as the billet referred to arrives by crane. When the billet reaches the 28-inch mill it is often necessary to carry it to the stamper, or the shears, in which case the operator at the 28-inch mill transmits to either of these places the identical line of data he has received from the soaking pits regarding this particular billet. It is desirable that the operator at the 28-inch billet-mill shears write general communications regarding the work to the 28-inch billet mill, and for this purpose the one-way line is used.

The design and great advantage of this system is that the instructions in regard to the billets are accurately transmitted to the proper stations in advance of their arrival. In this way a great saving of time and confusion due to mistake is effected.

Press Tools for Oil Drum Nozzles

By Walter G. Groocock

A large quantity of oil drums were to be made, and the tools shown in the illustration were designed and made by me for wiring and flanging the nozzles, or necks.

Fig. 1 shows the nozzle, which was made from 23-gage tin; 15-gage wire was used, and the specification laid it down that the wire must be thoroughly covered. Curling, or wiring press tools, are, as a rule, fairly simple, but a complication was introduced here, owing to the fact that it was not intended to fasten the seam (a plain lap) of the nozzle until it was soldered in the fixing.

Referring to Fig. 2, which shows a plan and sectional elevation of the wiring tool in the closed position, it will be seen that the tool consists essentially of four principal members. *A* is the top tool, or curler, made of cast steel, hardened at the curling end to resist wear, bored to take *B*, and also counterbored for the spring. The purpose of the plunger *B* is to keep a pressure on the work during curling and so prevent any buckling. The plunger is made of cast steel, for stiffness at the knife edge, and is allowed sufficient travel to put a pressure on the nozzle before curling takes place, the travel being limited and adjusted by the lock nuts shown, a stiff spiral spring providing the pressure.

The bottom tool consists of the mild-steel base block *C* bored to the shape of the nozzle and counterbored to take the cast-steel supporting and forming ring *D*; three screws hold the ring *D* in position, and limit the travel, and small spiral springs push it upward so that the wire is held in the right position; if the ring *D* is allowed to go too high, or not high enough, false curling takes place.

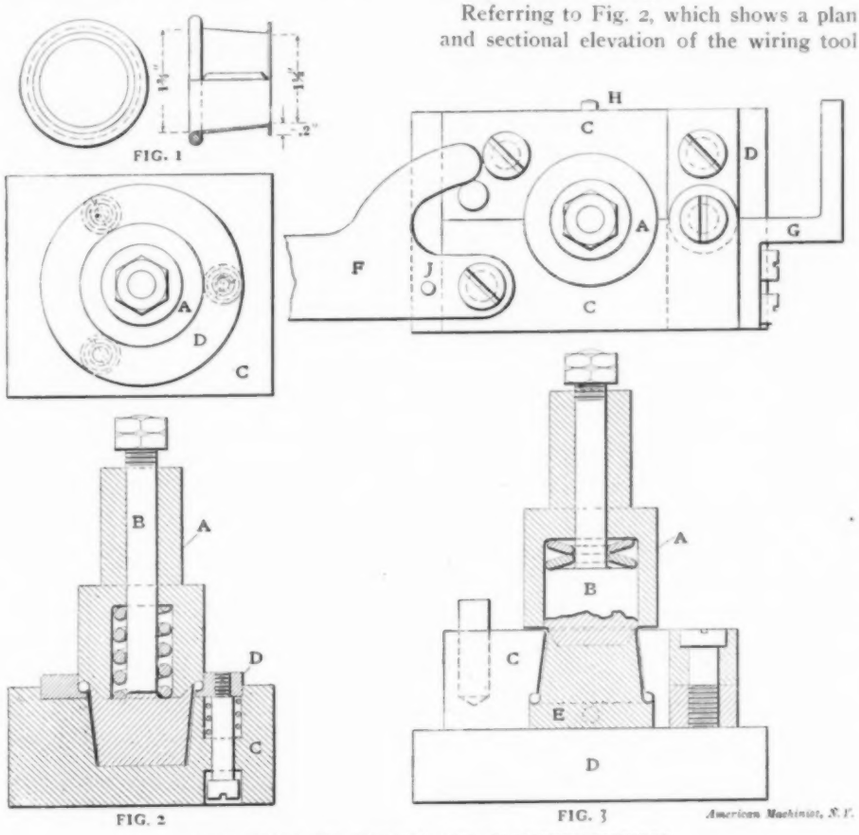
In using the tool the base block *C* was secured to a sliding table, and pulled forward to load it. The wire ring is placed on the ring *D* and the conical blank pushed into *C* (in which a groove is cut to accommodate the seam) the ends of the wire, of course, are placed opposite the seam. The tool is then pushed in and the ram coming down completes the operation, and if the blank is the right depth a perfect curl is the result. The tool is a simple one to make, but it is one of the many cases in press-tool work, where it is absolutely essential that the blanking tool should be made last to get the best results.

Fig. 3 shows the flanging tool closed, the elevation showing the front half removed and a section through the joint. This tool is a very good example of the fact that the method adopted is generally governed by the available plant. It is, however, debatable whether the operation of flanging this nozzle could be done either better or cheaper on any machine than it was on the press.

This tool has more parts than the curling tool, but is quite simple to make. The top tool *A* is bored to take the plunger *D*, and four disk springs, two only of which, for clearness, are shown, as in the closed position they are flat. The bottom tool *C C*, bored to the shape of the nozzle, and with a groove to accommodate the seam, is hinged, as shown, one-half being fixed to the base plate *D*, the other half swinging clear to allow the insertion of the work and the form *E*. The two parts of *C* are locked together by the cam lever *F*, which also acts as a handle to swing *C* open, the small pin *J* catching the corner of *C*.

In operation, *D* is secured in a standard holder, the cam lever *F* is swung to the right and a nozzle (as left by the tool, Fig. 1) is placed on the form *E*. The tool is closed and locked, and when the ram descends, the plunger *B*, which has 0.15 inch travel, curls over the part to be flanged, the springs being sufficiently strong to do this curling; *B* bottoms on the form *E* and the stroke continuing, the top tool *A* flattens the flange. If one tried to flatten the flange without first curling, it would split all round.

When the tool is opened, the nozzle may stick either in the fixed or moving part of *C*; if it sticks to the moving part it is ejected by a pin (not shown) in the base plate *D*. If, on the other hand, it sticks in the fixed part, it is ejected by the bracket *G* striking the ejector pin *H*. The whole of the tool with the exception of *C C* is mild steel, but the plunger *B* is case-hardened on its working face.



PRESS TOOLS FOR WIRING AND FLANGING NOZZLES

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Automatic Perforating Punch and Die

In the sketches herewith, *A* is a cup which has 16 holes, as shown in Fig. 1. To produce the work cheaply we made a die as shown in Fig. 2.

The operation is as follows: The cup *A* is put on the stud *B* and over the three clamps *C*, as shown, to stops *D*. After placing the work *A* to be perforated the operator is obliged to keep the press in motion until the work is done; that is, until the 16 holes are perforated. After the perforating operations are completed, the cup *A* is forced off by lever *E* and the work is done. They are forced outward by a coil spring and held in position by screws *S*. The spring *U* forces the rod *F* back to its normal position after it is operated for removing the perforated cup *A*.

The material used is brass 0.008 inch thick; the output is from 9 to 12 per minute.

Freeport, Ill. CHAS. EISLER.

A Novel Water Cooling Arrangement

The following account of a novel water-cooling arrangement may interest some of my fellow readers of the AMERICAN MACHINIST. In the shop where I am employed power is derived from two gas engines, one of which, an engine of 100 horsepower operated by suction gas, gave us some little trouble due to defective water circulation. This was caused partly by a bad arrangement of piping, and partly through the capacity of the water tank being too small. To keep the cylinder reasonably cool it was necessary to keep a fair supply of cold water continually running into the tank during the time the engine was working.

After a growl one day from the boss *re* his water bill, we rigged up the following with satisfactory results: To a beam which ran above the engine we fixed a light countershaft, and some 4 feet along the same beam a small rotary water pump was also fixed. This pump was driven from a pulley on the counter which in turn was driven from a pulley fixed onto the cam shaft of the engine. On the 4-inch return water pipe on top of the cylinder a hole to clear a 1-inch pipe was bored, and over this was clamped a gland, having a boss bored and tapped 1-inch pipe thread. This gland was necessary owing to the walls of the 4-inch pipe being too thin to tap.

Connection was made from the gland to the suction end of the pump through a cock. The pipe from the delivery end of the pump was carried through the roof of the engine room, right up to the ridge, right and left branches having a series of holes drilled in them being carried along the ridge for 10 feet on either side of the pipe. Through these holes the water was discharged right onto the slated roof, down which it ran into a gutter, thence by two pipes back into the water tank again. This arrangement, which does not interfere with the ordinary water circulation, but is meant to assist it, has been running for some time now, and has given every satisfaction. The water spreading in a thin film over the slates, helps the cooling considerably, quite a large reduction in temperature being the result. All that we require to do now is to occasionally put enough water into tank to make up for loss due to evaporation, no water going to waste.

Paisley, Scotland. T. K. POWRIE.

[We served our apprenticeship in Scotland, and there a little boiling water on the roof during summer might help to

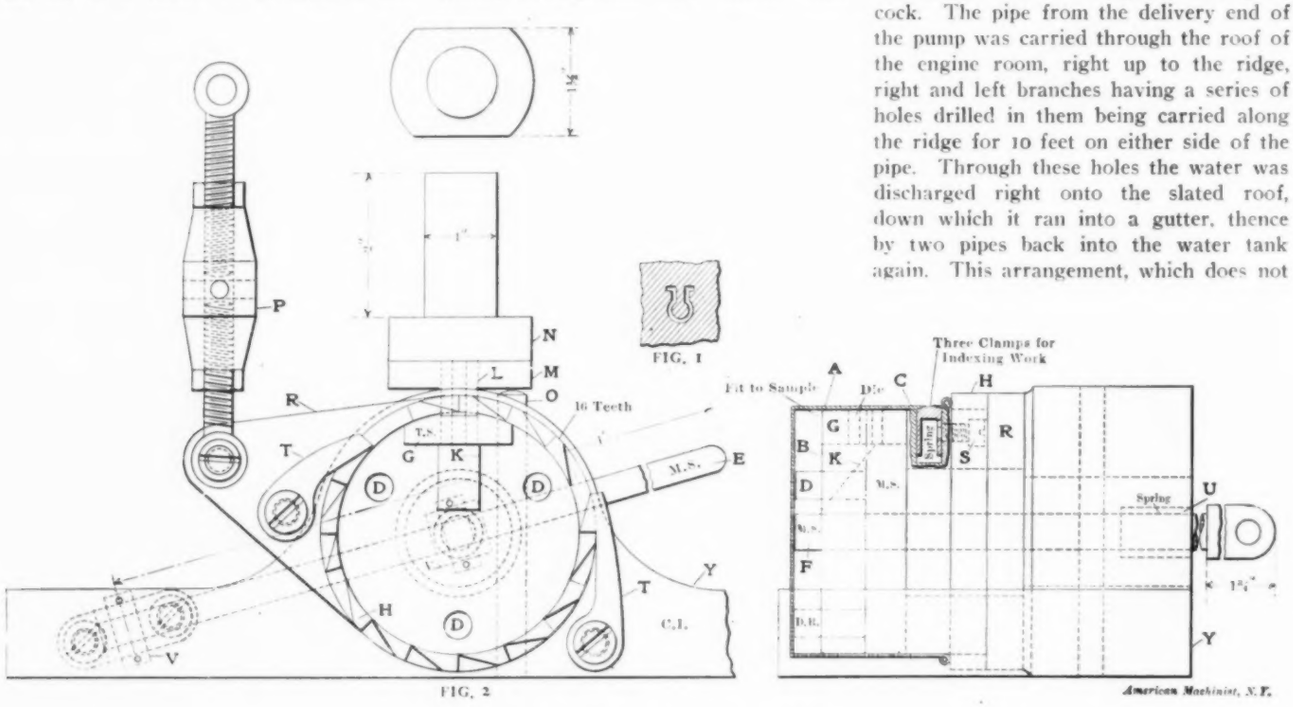


FIG. 2

AUTOMATIC PERFORATING PUNCH AND DIE

rod *F*. *G* is the die; *H* is the revolving ratchet on stud *B*; *K* is the opening where the scrap punchings fall through. The punch *L* is fastened in plate *M* on punch holder *N*. *O* is a pin which holds stud *B* in shoe *Y*. *P* is adjustable with right- and left-hand thread and connected to the power press slide, so that after every revolution of the press it will move the required distance. Rocker *R* is moved up and down in connection with the slide and carries two pawls *T*, which control the ratchet *H*. The three clamp plugs *G*, which are filed to a V-shaped end and hardened, hold the cup *A* until

make the "Yankee" workmen feel at home, but I am afraid the arrangement would not be popular with the machinists in the United States in the summer, and would freeze up solid in the winter.—Ed.]

Cutting Spirals in Disks in the Lathe

Last spring there came to our shop five hundred plain cast-iron disks 1½ inches thick and 10 inches diameter which required a continuous square groove, ¼-inch section, beginning at the periphery, and terminating 1½ inches from the center. Had there been but a half dozen or so, almost any one of several methods would have answered; the profiler, or the milling attachment on the slotter; however, it was thought best to machine these disks in the manner herein described. The groove was one-half inch pitch.

First, a pattern was made, and the special gear, shown in Fig. 2, was cast; also two 26-inch parallel blocks. The machining done on these is, of course, obvious, and no space need be taken up in describing it. A 16-inch lathe was used, the cross feed and tool block removed, and across both bearings on the front and back ways of the lathe two parallel blocks were laid. On the blocks the new 26-inch parallels were firmly bolted overhanging the end of the carriage toward the headstock about seven or eight inches. These overhanging ends were supported by two pieces of wood, as shown in Fig. 1, to prevent vibration in the work. Then a head was taken from one of the small planers and bolted to the faceplate, as shown in Fig. 1, and a ¼-inch square point was bent and clamped as shown. The size of the pinion was determined without trouble, and, while the readers of the American Machinist need no suggestion from me on this point, I might as well mention it as it may save a little time for some one. The pitch of the screw in the planer head was 1/6 inch; the number of teeth on the special gear was 174. Since the pitch of the spiral groove was to be ½ inch; $\frac{1/2}{1/6} = 3$, so the proportion of the two gears is as three to one. Thus the pinion had 58 teeth, giving for one complete revolution of the faceplate three revolutions of the pinion and a tool travel of one-half inch per revolution of line spindle. The handle, secured by a taper pin, was removed and the pinion secured by a key, as shown. The head was then bolted to the faceplate, far enough from the center to allow the tool to be set five inches from the center, to begin its cut. The special gear was set in mesh, and bolted down in a manner similar to securing a center rest. The disks were centered and a 1½-inch reamed hole put through as required. Two and one-half inches from this center two holes, ⅜x½ inch deep were drilled diametrically opposite to fit pins in the angle plate. The disk was then bolted to the angle plate, the angle plate bolted on the 26-inch parallels and the carriage run up for the cut. The tool was allowed to come up against the work, the center of the tool marked on it. The tool was then pulled around one complete turn by hand and the work was marked again, the distance between the two marks being measured, to prove the accuracy of the pitch. Then the lathe with back gears in was started, the tool, of course, having been backed out by hand and the carriage having been run up for a light cut. When near the end of its cut the tool was pulled through by hand, then backed up and another cut started. Of course, the disks were faced and turned before starting the spiral cutting. After cutting the spiral the required three-eighths keyway was located. It was, therefore, not necessary to start the square-point grooving tool at any particular point. After the first four were put through the job was turned over to a second-year apprentice. He put the remainder through at the rate of six per hour. The chief difficulty with this rig is the impossibility of obtaining a good support for the tool, therefore light cuts must be taken. The rig is, of course, adapted to cut spirals of other pitches, and the special gear may be moved and set either toward or from the faceplate to take either a smaller or larger pinion.

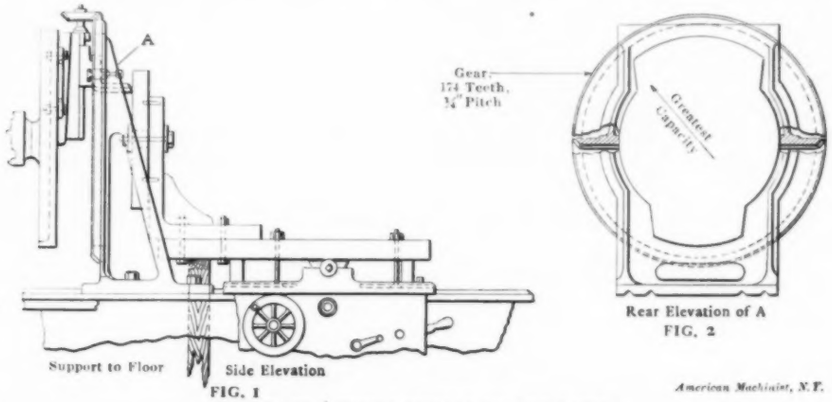


FIG. 1 FIG. 2

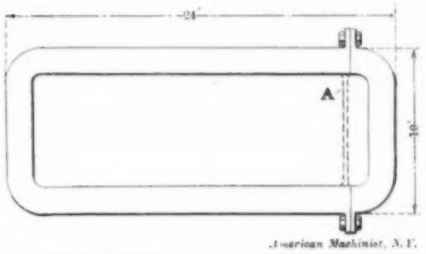
THE RIG FOR CUTTING SPIRALS IN THE LATHE

Everything must be made firm and kept so. In drilling the angle plate, center and stud holes for this job, the best way is to set the angle plate on the parallels, as shown in the drawing, put a center in the line spindle and jam the angle plate against it lightly; from this center mark lay off the stud holes, say 2½-inch radius, and there you are. One more detail should perhaps be mentioned. The screw in the head we used happened to be left hand and as the spiral was to be right hand we could run forward for the cut, and back up on the reverse as usual. The screw will always be of the opposite hand of the spiral; and the cut will be to or from the center; a right-hand screw will cut from the center and the cut should be started with a drilled hole.

Scotch Plains, N. J. Chips.

A Compressor Base of Faulty Design

The accompanying illustration shows a large air-compressor base that was very poorly designed. It was necessary to have one end of the base removable so as to assemble the machine readily. To allow for this one end was cast separately to be bolted on. The base itself was cast with a tie bar across the open end, as shown at *A* in the illustration. This bar was intended to hold the legs from warping out of true while cooling. After making the casting it was necessary to remove the tie bar in order to allow the machine to be assembled, as a part of the casing that projected below the base was slid on over this end.



A COMPRESSOR BASE OF FAULTY DESIGN

When the tie bar was cut out the legs of the base sprang out two inches. To allow for this the pattern for the base end piece was lengthened two inches and the compressor was assembled in this manner, with its base two inches out of square. This made a botched job and illustrates very forcibly how not to make a casting of this kind.

Since it was desirable to have one end of this base removable, the base should have been cast in four pieces and have had both ends bolted in place. A U-shaped casting like the above will always spring when one end is released and it is practically impossible to predict the amount of spring so as to allow for it in the pattern.

Kenyon, R. I. H. M. Nichols.

Convenient Size Blocks

A set of size blocks, if accurate, is one of the most useful adjuncts to a toolmaker's outfit, especially after he has used a set a few times, for he continually finds new ways to use them to advantage and he often wonders how he ever managed to get along without them. Anyone can make a set in a short time and at very little expense.

There are twelve size blocks in the set shown in Fig. 1, these ranging in thickness as follows:

.1001 inch.	.1009 inch.
.1002 inch.	.101 inch.
.1003 inch.	.102 inch.
.1004 inch.	.103 inch.
.1005 inch.	.104 inch.
.1006 inch.	.105 inch.
.1007 inch.	.106 inch.
.1008 inch.	.107 inch.

All are ¾ inch in diameter and made of tool steel.

With this combination one can get any length by 64ths of an inch up to 27/16 inches.

To make a set of these blocks, cut the steel to length, allowing 1/64 inch or more to finish. Mark them if you wish with the sizes they are to finish and harden in oil, then grind to within 0.0015 of the finish size, using a magnetic chuck on a surface grinder if possible; if not, they can be ground to good advantage on a universal grinder, care being taken to see that they are flat and parallel or they will not be reliable. Next finish the blocks on a cast-iron lap provided with narrow grooves running across its surface, using No. 120 emery at first, then flour-of-emery to finish, being sure the micrometer you use is absolutely correct.

The surfaces of these size blocks have a polish like a mirror and can be held suspended as shown in Fig. 2; this is due to atmospheric pressure.

My experience was that the thinnest block was the most difficult to make, for it required three efforts to get it satisfactory, that is, absolutely parallel and of an even thickness throughout. The first time the pressure of the finger on the block while lapping would tend to make it hollow in the center and it was too thin there before it was discovered. The next one was no better because I tried to distribute the pressure over the whole surface with a piece of rubber; this distorted the disk so that it was too thin in some places and too thick in others. The next and final attempt, which was successful, was as follows:

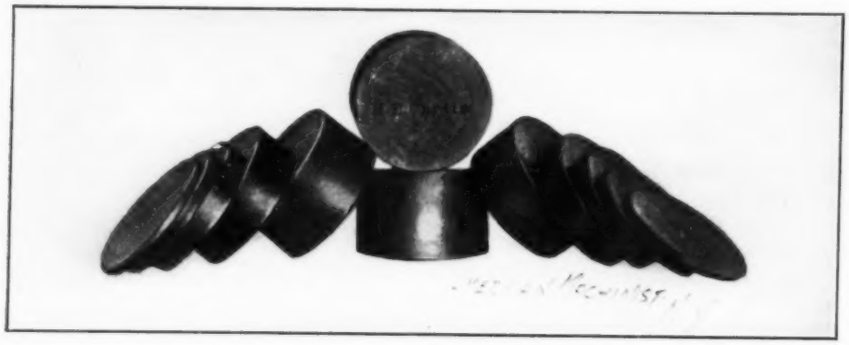


FIG. 1. A CONVENIENT SET OF SIZE BLOCKS

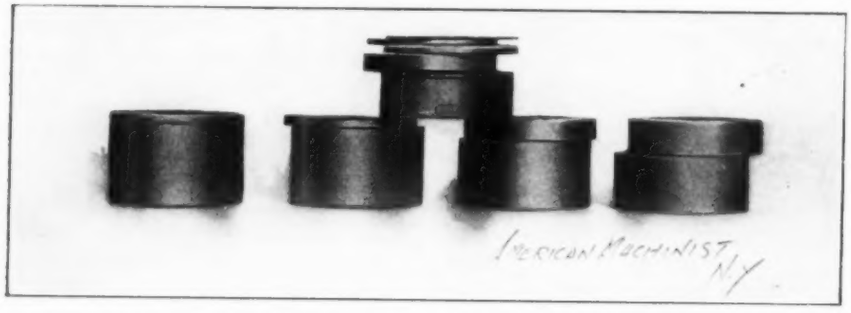


FIG. 4. DIFFERENT COMBINATIONS OF SIZE BLOCKS FOR SAME TOTAL THICKNESS

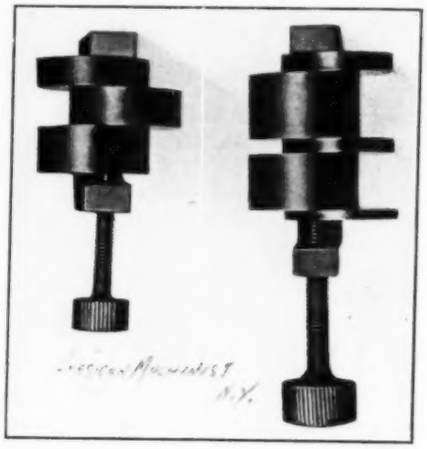


FIG. 3. SIZE BLOCKS ARRANGED AS SNAP GAGES

A ring with a hole slightly larger than the disk was used; this was placed on the lap and the thin disk dropped inside, then by the use of one of the longest blocks that had been finished, which was placed above the thin disk in the ring, a uniform pressure was obtained with the forefinger while the thumb and second finger pushed

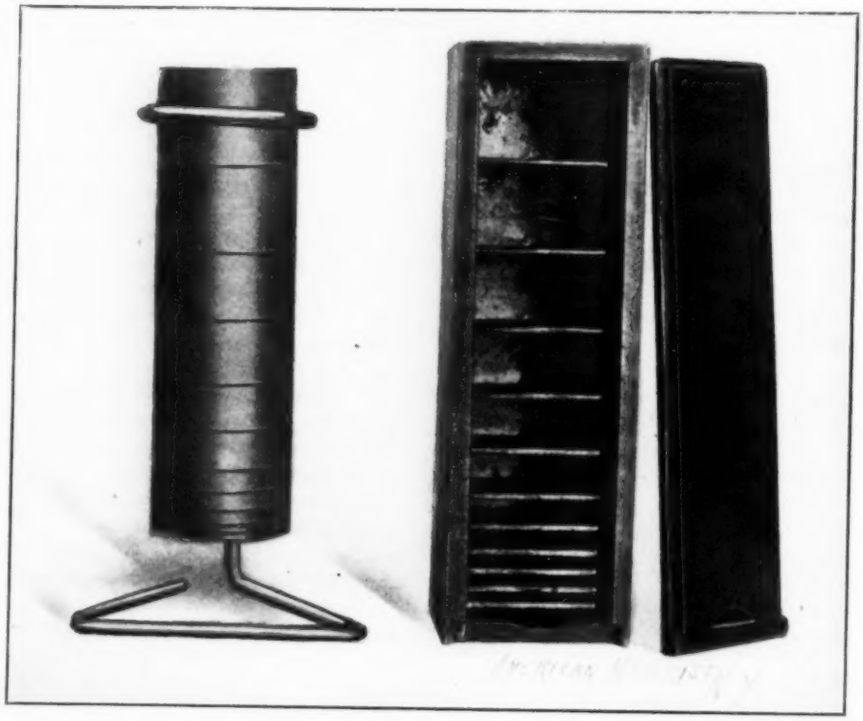


FIG. 2. SET OF SIZE BLOCKS WRUNG TOGETHER AND SUSPENDED VERTICALLY

the ring forward and back over the surface of the lap. By watching carefully the progress made, the desired result was obtained.

Two or more of these blocks may be clamped together with a small C-clamp to make a block, other than those in the set.

To make inside and outside snap gages, of anything in the combination, clamp three or more of the blocks together as shown in Fig. 3. Five blocks clamped together will give you two such gages; seven will give three, etc.

The blocks can be used for parallels; for instance, four ½-inch blocks, Fig. 4, can be made as follows:

½, 7/16 + 1/16, 5/16 + 3/16, and ⅜ + ⅛, etc.

In fact these size blocks are almost indispensable.

H. E. CURTIS.

Dayton, Ohio.

A Handy Shop Truck

The truck shown has proved very serviceable in the toolroom of an electrical plant where many heavy dies and fixtures were made. The unusual feature about it is the hight which is the same as the benches in the shop.. It is easy to slide work several hundred pounds in weight from the bench onto the truck, and off the truck onto the planer, shaper, lathe and milling machine. The hight is probably too great for the marking-off slab and drill press but it is better than having it too low.

A HANDY SHOP TRUCK

The body is built of 1-inch pine boards, in the form of a box, which makes it very rigid. The smooth sides are an advantage as there are no stays or struts to get caught in the screws, gears and handles of machines while the truck is being shunted about among them. It will be noticed that the boards forming the sides are staggered in relation to those forming the ends. There is a reinforcing timber in each corner, and diagonal braces inside on the sides. The boards are laid crosswise on the bottom and top, and hardwood is laid longitudinally above this; all being held by wood screws.

There are six wheels, free on the axles, and the middle axle is ¼ inch lower than the others. It will be seen that if the truck is balanced on the middle wheels it can be turned completely around in its own length. Thus it is possible to place this truck in some positions which are altogether inaccessible to the usual type.

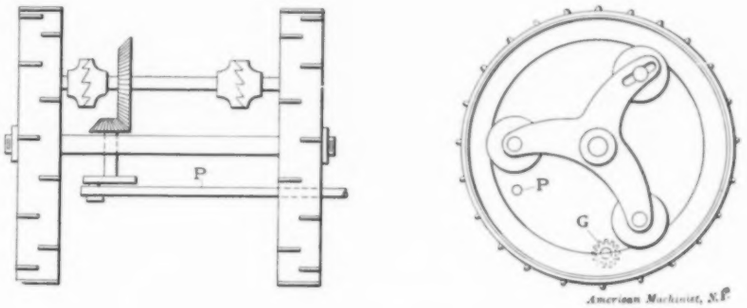
F. J. B.

Brooklyn, N. Y.

A Connecting Rod that Works Through a Driving Wheel

I recently ran across a novel piece of machinery in the form of a mowing machine which I was informed was called the Granite State mower and that it had undoubtedly been in use every season for forty years or more.

The feature that attracted my attention was that the connecting rod or pitman *P* passes *through* the driving wheel on the right-hand side of the machine and works as the driving wheel revolves which sounds a little puzzling until a sketch of some of the working parts is given.



DRIVING MECHANISM OF AN OLD MOWING MACHINE

Securely fastened to the main frame casting of the machine is a spider with three grooved wheels attached to the outer ends of the arms. The two lower ones have stationary studs upon which they run and the upper one has a movable stud made adjustable for taking up lost motion.

These grooved wheels run on an internal flange of the driving wheel as shown in the sketch.

The driving wheel on the left-hand side has hub and spokes as usual and turns freely on the axle.

Both driving wheels have internal gears near their rims which mesh with pinions *G* on each side of the machine. These two short pinion shafts, which are connected to the bevel-gear shaft by the two clutches shown, revolve when the drivers turn.

The half of the clutches that are attached to the bevel-gear shaft can be thrown in or out by a small lever, not shown.

The bevel gear meshes into the bevel pinion and drives the crank shaft, which in turn drives the pitman.

The bearings for all the shafts are either a part of the main frame or are solidly attached to it the same as the spider. Thus the pinions *G* and the pitman *P* always remain in the same relative position with the spider, which supports the right-hand driver, this driver having no hub or spokes. The cutter bar and knives closely resemble those in common use.

MARTIN H. BALL.

Watervliet, N. Y.

The Calibration of Industrial Pyrometers

The indications of the pyrometer, like the results of chemical analysis, are misleading and worse than useless unless they are accurate, or, if at all erroneous at least uniformly so. Some means therefore of checking pyrometer readings and of standardizing the instrument from time to time are essential.

The laboratory method is to insert the couple into molten substances which have a definite freezing point, and during cooling to observe carefully the point at which the temperature remains constant owing to the evolution of the latent heat of fusion. This is also the most suitable method for industrial purposes, presuming correct substances having definite melting points are chosen. The substances chosen should have the following properties:

1. The freezing point should be sharp and continuous for at least as long as is necessary to comfortably make an observation.

2. It should not be subject to oxidation, or its freezing point should not be altered if it should chance to become oxidized.

3. Its indications should be the same however often the observation may be made.

4. It should not attack the iron casing of the couple, nor should it be injuriously affected by contact with the iron casing at high temperatures.

In short, what one requires is a substance which can be melted in an iron or a graphite pot in the smith's hearth without any of those special precautions which, though easily complied with in the laboratory, it is almost impossible to observe in the forge.

Tin, lead and zinc can be used and are easily obtainable in a sufficiently pure state, but they oxidize very readily and moreover their freezing points, 232 degrees, 327 degrees, 419 degrees Centigrade, are too low for general use. The freezing point of antimony (632 degrees Centigrade), of aluminum (657 degrees Centigrade), come nearer working temperatures, but they are not easily obtained of a sufficient degree of purity, and they also readily oxidize and are otherwise easily contaminated. Silver, which freezes at 962 degrees Centigrade, is excellently suited for the purpose, but it is expensive. Copper may be used, but its freezing point, 1084 degrees Centigrade, is subject to a variation in temperature of 10 degrees Centigrade by exposure in the molten state to the atmosphere.

While therefore metallic substances can be satisfactorily used under suitable conditions, they are by no means as convenient as could be desired, nor do the freezing points of those which might be used fall within the temperature ranges mostly used in the heat treatment of steel and iron. On the other hand, however, some salts of the metals meet almost every requirement, and from among the great number of mixtures which can be prepared a suitable substance may be selected for making a calibration in any desired range of temperature.

Take the example ordinary table salt; not any of the fancy salts or the non-caking varieties which contain something else besides salt, but the common loaf brand. Its freezing point lies always between 795 degrees and 800 degrees Centigrade, and the same material can be used over and over again with perfect satisfaction. The manner of using it is as follows:

Fill an iron or a plumbago crucible which will hold about a pint with the crushed salt and set it on the smith's hearth, or heat it by any other available means until the salt becomes quite molten. Then place the end of the couple into the molten salt and close to the other end (the cold junction) tie a thermometer. When the hot junction has had time to attain the temperature of the molten salt remove the crucible from the fire and pack it among dry warm coke. Now carefully observe the indicator which begins gradually to fall. As soon, however, as the salt begins to freeze, the indicator remains stationary or it may even rise slightly and it does not again begin to fall until the salt is quite set. Observe also the temperature of the cold junction as indicated by the thermometer and calculate as follows:

Instrument originally calibrated at say 25 degrees Centigrade.

Pointer came to rest against the mark 790 degrees Centigrade.

Cold junction temperature, 30 degrees Centigrade.

Therefore 790 on the indicator corresponds to 800 degrees $-$ 30 degrees $+$ 25 degrees $=$ 795 degrees, that is, the instrument is indicating 5 degrees low.

The salt may be remelted in a few minutes in order to repeat the observation; and finally the crucible when cold may be wrapped in paper and kept available at a minute's notice to check any instrument which may be in use.

It may be and usually is desirable to have several substances whose freezing points lie along the range of temperature over which the pyrometer is being used. Such substances, in the form of salt mixtures having guaranteed freezing points, are manufactured by the Amalgams Company Limited, of Sheffield, England.

In using either salt mixtures or any other substances for calibration purposes it is absolutely imperative that all traces of one substance be removed from the couple before it is immersed in another substance. If salts are used it is sometimes much easier to slip off the iron tube and immerse the naked couple in the molten mass. The salts do not harm the couple in the least, but the same method cannot of course be used with molten metallic substances.

If the naked couple is available a piece of say 0.9 per cent. carbon tool steel, whose critical temperatures on cooling have been carefully determined can be used over and over again if a hole is bored to receive the end of the couple. The piece of steel containing the couple should be placed in a small graphite crucible and may be heated either on the smith's fire or over a brazier's lamp. A piece of steel prepared in the manner indicated has an advantage over most other substances which might be used for calibrating pyrometers. It can easily be obtained in any desired quantity; it can be replaced without trouble. It is true that only a very limited range of temperatures can be checked in this manner, but the range for most purposes of heat treatment is the only one that is of any importance.

In very large factories where maybe a score of instruments are regularly used, it is advisable to appoint a man especially to keep them in good order and make periodic calibrations. Even such a precaution, however, does not prevent a sudden lapse or failure which may have serious consequences.

It is advisable therefore to check the instrument from day to day under working conditions by reference to some standard which is not subject to variation. This can very readily be accomplished by placing a "Sentinel" in the furnace near to the end of the couple and taking the galvanometer reading as soon as the sentinel melts, or by smearing the end of the couple with sentinel paste which persists as a white mark until its melting point is reached. As soon as the melting point of the paste is reached the white mark disappears and just at this moment the galvanometer reading should correspond to the melting point of the paste.

Both the sentinel and the sentinel paste may of course be used as pyrometers without reference to any other instrument. Indeed, for tools which have to be annealed or hardened in the smith's fire it is about the only practical form of temperature indicator available. No preparation is necessary, and it is difficult for an intelligent person to go wrong.

The end of the tool is smeared with a paste of a suitable melting point; say 770 degrees Centigrade, and heated either directly in the fire or protected from the coke by a piece of scrap wrought-ion pipe. When the hardenening temperature is reached, the white powder disappears and indicates that the tool should be withdrawn and quenched.

It is quite as easy in this manner to harden a casual tool either in the shop, by the roadside, or at the mine with the same degree of accuracy as can be attained with the usual equipments of a good hardening shop.

Sheffield, England W. H. D.

A Substitute for a Turret Lathe for Machining Brass Stuffing Boxes

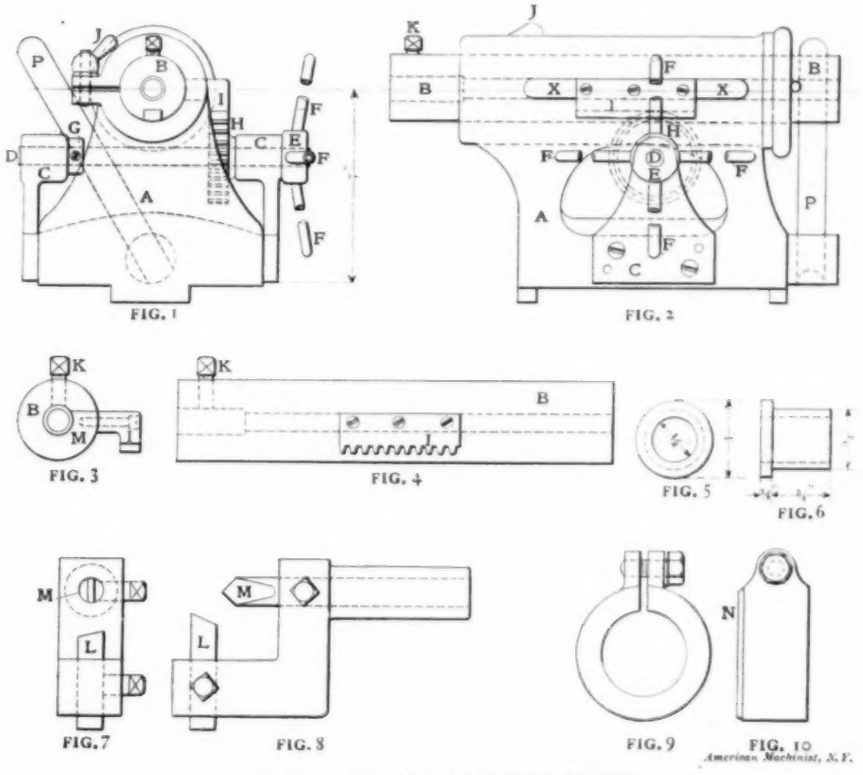
Having been a reader of the AMERICAN MACHINIST for a great number of years, I have appreciated the ingenuity and resourcefulness of those who have devised "a means to an end," and designed the jigs, tools, and fixtures which have appeared from time to time.

Some of these "rig-ups" occasionally present original ideas in their design, whereby they dispense with expensive machines and do the work at low prices with a comparatively small outlay. At other times I have come across specific cases in the shops where expensive tools and equipments have been designed and made to perform a comparatively simple operation, where it is very doubtful whether the output will ever repay the cost of the jigs and fixtures. Toolmaking is often carried to the extreme, in one shop I am acquainted with.

Some time ago this firm went to the expense of designing and making the substitute for a turret, shown in Figs. 1, 2, 3, 4, 9 and 10, to produce the brass stuffing box, shown at Figs. 5 and 6, from the bar. The superintendent had an idea he could rig up a machine for making these in record time, hence the result shown. We had a 14-inch turret lathe with wire feed and automatic chuck, the turret of which was missing, so we got a casting of a tailstock with an enlarged barrel, as shown at *A* in Figs. 1 and 2. This was bored as usual, to take the ram *B*, which is of machinery steel. *C C* are two bearing brackets secured at each side of the headstock by two fillister-head screws and two dowel pins, shown in Fig. 2. These brackets support the shaft *D*, which carries the boss *E*, and star-feed handles *F*. *G* is a loose collar secured by the grub screw, shown in Fig. 1, and *H* is a steel pinion, keyed on the shaft *D*. It operates the ram *B* through the medium of the rack *I*, which is secured to *B* by the three screws, shown also in the elevation, Fig. 4, and end view, Fig. 3. This rack is a nice sliding fit in the slot *X*, Fig. 2, which limits the working stroke of the ram *B*. *J* is the ordinary locking handle for keeping *B* properly adjusted and to take up wear. *K* is a set screw for securing the tool holder, shown in Figs. 7 and 8, *L* being the turning tool and *M* the drill for boring, both being secured by the two set screws shown.

Figs. 9 and 10 show the adjustable stop, which slips on *B* at the back end. The faced side *N*, Fig. 10, comes up against the faced collar *O*, Fig. 2, and forms a dead stop for the "capstan" *B*. *P* shows the locking handle of the eccentric type for securing the headstock to the bed. With the rig here shown, only the boring and turning can be done, both performed at one operation, the stuffing boxes having to be parted off by the usual type of cut-off rest. The machine certainly does its work satisfactorily, but its application is extremely limited, which makes one think, was it worth the money expended on it? A capstan would have cost very little more, and would have had a far wider range of work within its scope. With a capstan having six holes for various tool holders, three boxes could have been produced per revolution of the capstan, the output would have been considerably greater than with the device here shown, and the machine could have been employed on a variety of profitable work which does not now come within its scope. In my opinion this tool making is carried too far by some of our ingenious mechanics in certain shops. This I consider a flagrant case, with all due respect to the originator of the idea.

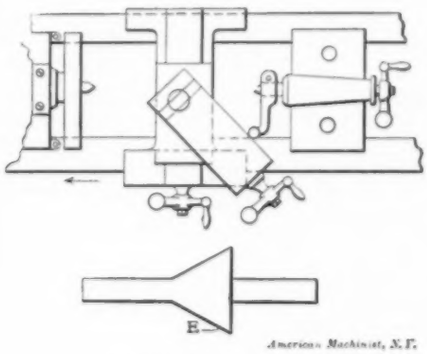
London, England. J. T. CROSLEY.



THE WORK AND THE SUBSTITUTE TURRET

Turning Acute Tapers

In the accompanying line-cut a simple lathe attachment for turning a quick taper is shown. The taper shown on the piece at *E* is quite hard to turn with the ordinary taper attachment owing to its excessive taper, while with this it is easily turned.



TURNING ACUTE TAPERS

The cut shows a part of a lathe with a bracket clamped upon the tailstock. This bracket consists of an arm having a slotted collar with a clamp screw for clamping it to the tailstock center. At the opposite end the arm carries a small roller that bears against the side of the compound rest.

By setting the compound rest for the desired taper and engaging the cross feed, it causes the side of the compound rest to come in contact with the roller and this forces the main carriage in the direction shown by the arrow, while the cut is being made.

I have seen this working against a ¼-inch cut, on steel, with perfect ease. You can readily turn steep tapers and can adjust the same by winding the compound rest and setting the tailstock screw. The device is a simple and effective one and works with great accuracy.

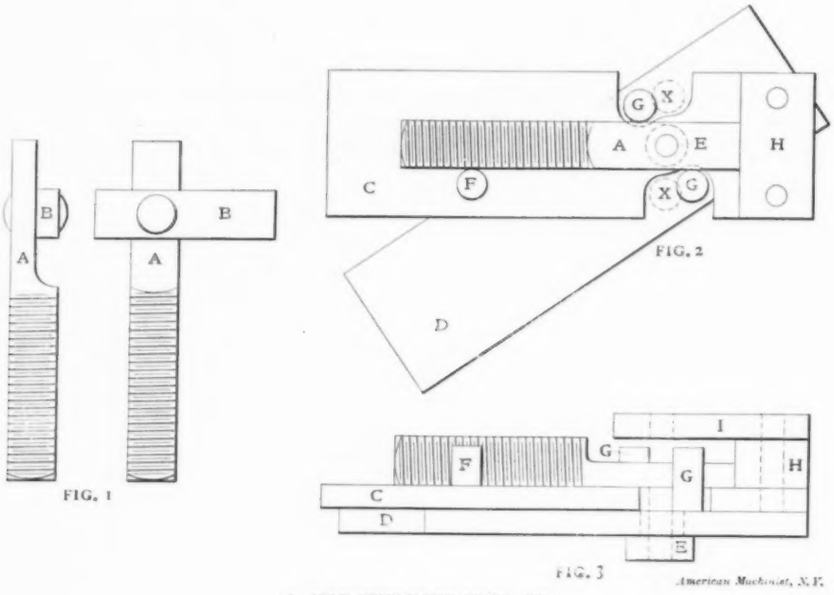
C. R. MCGAHEY.

Lynchburg, Va.

An Efficient Self Centering Drill Jig

Recently I got a hurry job to drill some bolts like the one shown in Fig. 1. The bolts consisted of a piece of ½-inch iron threaded at one end and flattened at the other end. On the flat part *A*, a piece of ¼x½-inch iron *B* 2 inches long was fitted loosely on a ¼-inch rivet.

First I got two pieces *C* and *D*, of ½x1¼-inch iron 8 inches long. In the center of each piece 1½ inches from the end a hole was drilled for a stud *E*, shown dotted in Fig. 2. The stud fitted tight in the top piece *C* and loose in the bottom piece *D* and it had a clearance hole for the drill through the center. On one end of the stud was a shoulder, shown in Fig. 3, which was to rest against a cup



A SELF-CENTERING DRILL JIG

center in the tailstock of the speed lathe. On the top piece *C*, 2¾ inches from the end and ⅜ inch from the side, a pin *F*, ¾ inch long was fitted tight. On the bottom piece *D* at equal distances from both the center of the hole in *E* and the center of the piece *D*, two pins *G* were placed that were 1 inch long. The upper piece was cut away as shown to allow these pins to swing around the pivot stud *E*. On the end of the upper piece *C* was placed a small block of iron *H* which served as a stop. On top of this stop was placed a piece of steel *I* which had the hole to guide the drill. *H* and *I* were held to *C* by two rivets. The hole in the steel piece was drilled through the hole in the stud *E* when *I* was riveted in place.

The jig served to drill the two pieces *A* and *B* of the bolt. By placing one of the pieces between the pins *G* against the stop *H* on the end and against the stop pin *F* on the side and drawing the two legs of the jig apart, the two pins *G* swinging in the arc of a circle would center the pieces and jam them against the stop *F*. The whole jig was thought out and made in three hours and it answered its purpose very well.

Fig. 2 shows the jig with a drilled bolt in place, the drill guide *I* being left off for clearness.

Boston, Mass. J. J. HARRINGTON.

Back Gearing at James Watt & Co's

James Watt & Co. sounds queer! but there was a James Watt & Co., or rather the old works of Quaker Matthew Bolton, at Soho, a small village a little out of Birmingham, England, three miles or so, and two miles from Heathfield, where the old Nestor of the steam engine has rested in peace since 1819. I have been in the old works of James Watt & Co., that went on for many years after Watt's death, and about 1875 constructed a fine pair of pumping engines for Pimlico, London, and also made the copper pennies as a legalized mint for the realm.

What can we learn from these old things? A works where a cylinder could be bored so exact "that a sixpence could not be inserted between the cylinder walls and the piston." But even there we can learn something. Let us see!

James Watt & Co. was swallowed up so to speak, by the Cornwall Iron Works (Messrs. Tangye Bros.) many years ago, when their 5000 men swarmed over the place and Geo. Tangye, the manager, went to live in Heathfield Hall, Watt's old home.

I, an American citizen, had the honor of being invited to examine with Mr. Tangye and rummage Watt's old room and private shop, the care of which was insured by a bond of 1000 guineas by Mr. Tangye; but of this, another time. Now our business is with the shop, not with the square cast-iron shaft and large wooden drums thereon, or even the "grasshopper" engine that drove the works, which the man in charge said "had some new 'brasses' put in about forty years ago by my father and no repairs since then."

This was not the thing that impressed me; it was the manner of gearing the old tools. I was a toolmaker, a tolerably experienced one too, trained mainly by W. Bement in the Industrial Works, Philadelphia, but I learned something in this century-old shop; namely, to always put the back gearing of a metal-working machine on or at the main spindle and not on some other shaft or spindle to set up resilience behind the cut.

The old tools in James Watt & Co.'s were thus geared, to work solid, and here I first caught the idea which is far from clear to many toolmakers. It was not a new thing, because a few toolmakers here and in Europe had caught the idea, as is shown in their practice; but it is easy to find new tools, especially drilling machines, with their back gearing on a second or even a third shaft away from the cutting spindle.

Lathes are never so geared. They show the effect at once, as it is common in England to use the same gearing for lathes and drilling and boring machines. Suppose as a "deadly parallel" we assume an engine-lathe spindle to be driven by a pair of bevel wheels, a shaft from these wheels to the countershaft overhead and on the countershaft the back gearing. Absurd! And yet this has its equivalent in many modern machine tools and, I fear, some I have designed.

In our American drilling machines, it is common and, I think, expedient too, to gear the second or horizontal shaft at twice or more the speed of the main spindle. This furnishes a convenient place for the back gearing, also is the wrong place, except for single-geared machines that are not subjected to much strain. Such single-geared drilling machines were in the old Soho works of James Watt & Co. and as a strange feature the bevel wheels on the spindles were cog-wheels with wooden teeth.

Of course things looked crude to one of our time, or for forty years ago; but short reflection would bring back the time and circumstances of James Watt and Matthew Bolton and with it, perhaps, some thought of old Quaker Matthew, whom Pitt, when Prime Minister of England, consulted concerning a tax or duty on copper.

The old man, after a few minutes, made this answer: "Mr. Pitt, tax wealth wherever found. Tax the spending of it, but do not in any way tax the getting of it."

San Francisco, Cal. J. R.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Vacuum Experts

Mr. Ripley's experience, on page 139, with the "vacuum experts" is very amusing, and the problem he lays before the readers of the AMERICAN MACHINIST is a very interesting one. It suddenly occurred to me that I might obtain some amusing answers if I asked everybody I met in the course of a day or so to explain why it is that these bottles will keep liquids cool longer than hot. So I planted the query at many people and have come to the conclusion that the average person is only about as intelligent as the "vacuum experts" of Mr. Ripley's acquaintance, for almost without exception I was told that it must be because the heat traveled faster than the cold. I was at once delighted and sorry at the result of my experiment, but I hope this meets the eye of the "four-day-old expert" and his boss—for they will then know that there are others in the world, and may derive happiness from the knowledge.

On first thoughts the fact that the hot liquid cools quicker than the cold liquid becomes warm, is rather strange; but, if examined a little closer, it loses, I think, that quality, and presents facts that are directly in agreement with one's rational conclusions.

Taking the two cases: In the first place, consider a vacuum bottle in winter with the atmospheric temperature at 20 degrees Fahrenheit, filled with a liquid at 212 degrees Fahrenheit. There is a temperature difference of 192 degrees Fahrenheit.

In the second place, consider a vacuum bottle in summer with the atmosphere at, say, 112 degrees Fahrenheit—which is very high—filled with a liquid at 32 degrees Fahrenheit. There is a temperature difference of 80 degrees Fahrenheit.

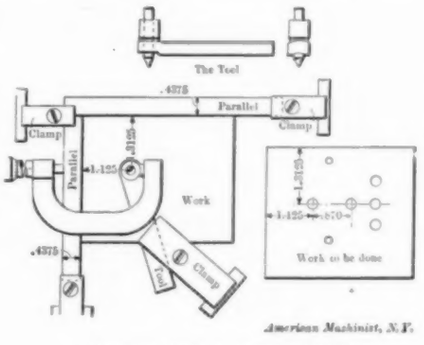
The temperature difference of the first case is 2½ times that of the second case; therefore it must be obvious that in the first case heat will flow more rapidly from the bottle than it could possibly flow into the bottle in the second case, because of the law that when heat is transmitted through a plate from one fluid to another the amount of heat passage is proportional to the difference in temperature of the fluids. This reasoning shows that under the conditions examined liquid can be kept cold about 2½ times as long as it can be kept hot. But these conditions are not likely to be met with by any vacuum bottle, and it is easy to see that, under more normal conditions liquids can be kept cool quite three times as long as they can be kept hot. For instance, with a normal temperature of about 72 degrees Fahrenheit the temperature differences are 140 degrees Fahrenheit and 38 degrees Fahrenheit, or 3.7 to 1. I hope this will satisfy Mr. Ripley.

Sheffield, England. CONAN.

Toolmaking Accuracy without the Button

Apropos of methods of laying out work by means of the button, the accompanying illustration gives a tool, and the method of using it, which is capable of giving as good results as that obtained by the button principle.

Like everything else in life, it is not so much the accuracy of the thing itself



ANOTHER TOOLMAKERS KINK

as of the man behind the thing, and anything will become inoperative unless used with understanding, and that should be the toolmaker's chief stock in trade.

THE TOOL

This is shown at the top of the drawing; it should be made of material capable of being hardened but is not necessarily confined to that particular shape. It must be accurately made; that is, the hole must be at right angles to the bottom face, which is easily accomplished by machining the bottom first, then clamping on the faceplate of the lathe and boring the hole, allowing for grinding after hardening. After hardening, the bottom face should be lapped, the faceplate of the lathe faced off and the hole ground to some standard size, in case it should be desired to use it as a drill jig. It is then placed on a mandrel and the outside of the cylinder ground to some standard size, preferably a size that is divisible by 2 without a fraction.

The center punch is made with the stock enough longer for holding in the chuck for grinding body and point at one and the same time to insure concentricity.

USE OF THE TOOL

The illustration is practically self-explanatory. The parallel strips, which are a part of every toolmaker's kit, are clamped at right angles, care being taken to insure accuracy of the right angle. The strips should be about ¾ inch high and clamped on edge to facilitate the use of the micrometer. The die stock or work is squared and placed between the parallel strips and the tool clamped on the work as shown in the sketch, with just enough tension to insure holding it in position. The micrometer is used from both sides of the angle and determines the position of the hole, when a slight blow of the hammer on the center punch fixes the spot for the wiggler.

With care, all the holes can be laid out at one setting and if the wiggler is carefully used, much time can be saved, and extremely accurate work can be done. I have seen some very poor results from the button principle and some very good ones, too, and have obtained the same accuracy with this tool. It is just another method of doing the same old thing and is open to the same criticisms, so bring them along.

Brooklyn, N. Y. W. J. KAUP.

Hardness and Carbon Contents of Steel

On page 210 of the AMERICAN MACHINIST I notice that E. F. Lake—who is regarded as one of the foremost elucidators of metallurgical subjects in this country—has criticized my last article, published on page 1066, Volume 32, Part 1, and which treats on the above subject.

While I invited criticism in this article, I really hoped it would come from someone more closely connected with the laboratory or factory; nevertheless, I shall answer the best I can.

Mr. Lake, by quoting some paragraphs of my article, thinks himself able to show that in my attempt to throw light on that phase of hardness in metals which is of the most vital interest to manufacturers and importance to the arts, I have contradicted some preceding statements. Hardness is a phenomenon that cannot be explained away in a simple, clear way, as Mr. Lake would like to see it, and I admit that, in confining the article to manufac-

turing and engineering science insofar as metals are concerned, it was left vulnerable from some other viewpoint.

Mr. Lake says that, according to my article, "hardness is the thing the scleroscope measures, and the other things are not hardness," although he fails to note that I have summed up this property as being proportional to the power of a metal to resist penetration.

Now, therefore, when we deal with a steel so crystallized as to allow the scleroscope to penetrate it, more than one having the power to resist it, then, from my viewpoint, it is softer. This is what the scleroscope shows; it is what shop men and engineers want to know and must know if they would benefit by the use of such an instrument. That the individual crystals of burnt steel, condemned as softer by the scleroscope, may be as hard as that which gave a higher reading is admitted, but shopmen care little or nothing about these things when they are held responsible for the proper performance of tools or machine parts made by them.

In dealing with silicious minerals I have to state that the scleroscope is not designed to measure their hardness, and does not need to, for there is the old sclerometer, which scratches with a diamond point which does this work, but which curiously enough cannot be relied on for testing metals unless, perhaps, in a way, hardened steel.

In most minerals in which the hardness is greater than in steel the accompanying brittleness is so extreme that neither the Brinell ball-test machine, nor the Shore scleroscope can be applied without crushing before the reading can be obtained.

Mr. Lake says further: "It is not hardness alone which he measures, but a combination of hardness with toughness." What is toughness? This is a property of metals that I long hoped to see Mr. Lake tackle in his usual thorough way. Someone gave this nut to the Carnegie Institution to crack lately, and it had them guessing, for no means has as yet been invented for measuring it. The toughest metal known to the arts is manganese steel, and on this the scleroscope only reads about 40. Yet it cannot be machined, although some other steels, also measuring 40, can be machined, while cast iron of the same hardness can easily be worked. Why is this? Can toughness be determined by comparing the hardness with machinability? Apparently it can in an approximate way, but it is not the right way. Toughness is a property which must be calculated, and this is regularly done by hundreds who use the scleroscope.

The process consists simply of bending a piece of the metal at a sharp angle up to the point where fracture begins. This gives us so many degrees of permanent bend, and we call it the ductility of the metal. Ductility alone in metals has little or no meaning to engineers, for the softer they are the more ductile they must be, but soft metals as lead or copper cannot be said to be strong.

If a metal, however, shows high hardness and ductility at the same time, then the combination is toughness, and it is found by multiplying the ductility by the hardness.

Cast iron may bend 2 degrees and is 40 hard, and $2 \times 40 = 80$ tough. A chrome-nickel steel bends 90 degrees, and $90 \times 40 = 3600$ tough. This metal can scarcely be machined with a blunt tool that would work well on cast iron. Manganese steel can bend 180 degrees at 40 hard, and the amount representing toughness is so great that machining is impossible with any kind of tool.

Experience shows that in selecting tools for various classes of work three factors are requisite—hardness, strength, and toughness. Hardness and strength combined stand for a high elastic limit and the power to hold an edge. As we have seen, great toughness may exist at a fairly low hardness, and since the elastic limit is proportional to the hardness, toughness begins to exist when hard metal shows a tendency to take on a permanent set after exceeding the elastic limit.

A tool having a high percentage of all three of these properties shows enormous efficiency, and, as a rule, it is very hard to get such a combination. I recently tried a piece of Columbia steel (high-speed) which was 95 hard, and which took on a permanent set of about 20 degrees. This steel had an ultimate strength of about 400,000 pounds to the square inch, and its cutting power and endurance on hard and tough metals was almost incredible. What was the toughness of this steel? It was $20 \times 95 = 1900$. On another sample of high-carbon steel tempered down to 88 hard, which had about the same strength as the high-speed steel, 4 degrees of permanent bend could be obtained so that its comparative toughness was $4 \times 88 = 352$. At slower speeds this made a tool of enormous power. These two steels were such as are found one in 100, for usually if, particularly carbon steel, is as hard as 90, it has practically no permanent bend to it, and, therefore, is not very tough, although it may have a strength of over 100,000 pounds per square inch, and it makes an excellent tool.

The diamond has shown very well that in all cutting operations hardness is capital, while strength and toughness follow.

As to my experience with metallurgical chemists, Mr. Lake has not made it easier for one to get two chemists to agree on the same sample. He also quotes Philo Kemery, who also criticized a former article from my pen to the effect that the solution-analysis method for carbon after all does agree with the combustion method.

In a number of instances I had special steels made up by Mr. Kemery's staff and found them so accurate that I believe all he may claim in this direction, but while the discoverer of the combustion method claims the solution method often reads low, Mr. Kemery misunderstood my article, for the comparisons I discussed were between the dynamic method, fully discussed in a later article, and the combustion method.

New York, N. Y. A. F. SHORE.

Thin Slitting Saws

Mr. Kirkland's article on "Thin Slotting Saws," page 219, reminds me of the difficulties I have experienced when working at the dental manufacturing business.

One of these jobs was slotting a small nerve probe collet made of ⅛-inch drill rod, and anyone that has tried slotting drill rod with a slotting cutter 0.012 inch thick, with the slot from ½ to ¾ inch in length, no doubt has had trouble in getting them straight. I did until I hit upon a simple device and my troubles were over on two jobs as it also answered for slotting a saw holder made of 3/16-inch drill rod, the slot being ¾ inch long.

Previously I had made a couple of fixtures, one of them quite elaborate, with indexing arrangement. Both were constructed to guide the saw above and below the work to keep it straight, but there is where I made a mistake. I had these guides hardened and the saw would carry the chips around and wedge on the sides and break the saws as fast as the remaining pieces could be removed from the fixture.

Next, I made two pieces of tool steel 3 inches long and ½ inch square, fastened together with two ¼-inch screws. I then milled a 45-degree angle on the dividing line, drilled and tapped for a small stud through from the top for the binding clamp for holding the work.

Toward the front and to one side was tapped for a 6x32 screw to hold a small piece, the thickness of the saw, to index the work on the quarter after the first slot was finished.

The two square pieces were then hardened, set up together on the grinder and ground down a little more than half the thickness of the saw and 13/16 inch back from the face. It was then assembled, held in a small vise on a hand miller, the work set slightly back from the face of the fixture to allow the saw to enter the slot (as there is a point on both these pieces) and from then on, there was no more trouble in getting these slots straight.

Cleveland, Ohio. R. E. ROBERTS.

The value of the slate quarried and sold in the United States in 1908, according to figures compiled by the Geological Survey amounted to $6,316,817, an increase of $297,597 over the 1907 output, in the face of the depressed conditions that prevailed during the past year.

AMERICAN MACHINIST

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September 9	19,250
September 16	19,250

This paper reaches 34,750 *separate readers each month and* 19,250 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Chicago Subscribers Please Note

Chicago subscribers are notified that the streets of Chicago have been renumbered. Please send us your old and your new addresses.

Wanted: a Definition of "Machine Tool"

The appearance of a special rate of duty for machine tools in the new tariff bill has already raised the question of the exact meaning of the term, this question arising from the fact that in previous tariff bills machine tools were not given a special classification but appeared with other machinery and at the same rate of duty.

The meaning of the term is fairly well understood by those who most use it, but unfortunately this understanding does not agree with the definitions given in the standard dictionaries to which reference will naturally be made by the authorities when the point turns up for determination.

Thus Webster defines the expression as "a complex machine for shaping materials; strictly an adjustable machine with an automatic feed for shaping metals by cutting."

The Standard dictionary gives this definition: "A machine for doing work with cutting tools, or one utilizing minor tools in performing the actual work, as a lathe, planing machine, rabbeting or tenoning machine; also a forming machine: opposed to hand tool."

The Century dictionary's definition reads thus: "Such machines as are used in shaping materials in the construction of the parts of other machines and many of those which perform work such as sawing, boring, planing, riveting, etc., formerly done only by hand and still performed manually to a greater or less extent, are commonly called, *machines, machine tools, engine tools* or simply *tools,* although their structure may involve much complexity."

Of these various definitions that of Webster is the most satisfactory, the second or limiting clause being quite closely in line with the general understanding of the words. Unfortunately, however, this is preceded by a clause which makes the meaning far too general in that it includes the shaping by any process whatever of any material whatever, and under it the term can only be construed to include wood-working machines, for example, which we are confident would not be thus included by anyone connected with the building of machinery of any class. This same extension of the meaning to include machines for cutting any material appears also in the definition of the Standard dictionary as it appears also in that of the Century dictionary with the further extension there to include shaping by other processes than cutting.

In the nature of the case and for the use of the customs officials, a definite meaning must be attached to the words and we do not see how any of the definitions given above can be accepted. The only satisfactory definition that appears is that in the second clause of Webster's definition and, even without the first clause which gives it a much wider meaning, this definition can scarcely be accepted in the face of the others which we have quoted, which can only be interpreted as giving a much wider meaning than was in the mind of those who were instrumental in having the new rate adopted, while manufacturers of wood-working machinery, for example, can scarcely fail to strenuously object to the inclusion of their product in a classification which no one in the trade accepts and which it was not intended to include when the tariff bill was drawn up.

The idea that was in the minds of those who were instrumental in bringing about the new rate was obviously the inclusion of the productive equipment and tools of machine shops, and it seems to us that the term can only be properly defined by keeping in mind the motive behind the new rate. To cover this we would suggest the definition: Tools of whatever character used in the production of the metallic parts of machinery.

In one sense this definition gives a wider meaning to the term than that commonly in mind, in that it would include a few tools which do not perform the actual operation of cutting, but on the other hand, it excludes wood-working machinery and machinery of other classes which do not properly belong in the classification.

With the unsatisfactory definitions of the dictionaries before them the customs authorities will, we suppose, be compelled to draw up or adopt a new one, and, inasmuch as the machine-tool builders were largely instrumental in bringing about the new tariff rate, it would seem only proper that they, through their organization, the National Association of Machine Tool Builders, should take action and inform the Government just what those who were instrumental in bringing about the new rate intended.

As we have said, the question has already arisen, and it must undoubtedly continue to arise, and, under these circumstances, some definition must be arrived at. On our own part we disclaim any attempt to pose as an "authority," and do not wish our suggestion to be understood in that way. The meaning of the expression can best be defined by those who make the things to be defined, and this we submit as the proper course to follow.

The sooner this is done the better, as, with a precedent once established, it may prove difficult to bring a satisfactory definition into use, should that involve a change.

Replies to Advertisements

From time to time we receive complaints from those who reply to our Help Wanted advertisements to the effect that their communications are not treated with due courtesy in the matter of acknowledgments. In some cases it appears that the inclosure of a postage stamp does not bring an acknowledgment and the result is naturally ill feeling.

We are well aware of the common practice of selecting from the replies to an advertisement those which seem most promising, and then following these up while the others are discarded, but we submit that such a practice is discourteous and that it should be dropped.

Of course, it is true that a vacancy can be filled by but one man, and that a negative reply can really accomplish nothing, but it must be remembered that those who reply to these advertisements do so because they are looking for positions, the replies being in many cases followed by a period of anxiety which would at least be cut short by a negative return letter.

The matter is of moment to us, because the very natural irritation over an occurrence which, in some cases, has been the repeated experience of correspondents, is not limited to the anonymous advertiser, but is extended to ourselves. Our correspondents seem to think that we are in some way responsible, and that their failure to obtain replies may be due to our failure to forward their communications to the advertisers—some, indeed, going so far as to express the opinion that we publish fake advertisements.

In these days of typewriters and manifolding processes the acknowledgment of a reply to an advertisement of this character is such a trifling matter that we can see no excuse for the practice which is altogether too common, and those advertisers who will endeavor for a moment to put themselves in the other man's place cannot fail to adopt the practice of acknowledging all replies to their advertisements. The finding of a man to fill a responsible position is surely a matter of enough moment to justify the slight additional effort involved in giving orders to a stenographer to acknowledge the receipt of all replies, and common courtesy dictates that this be done.

Machinery Trade in England—Erratum

At page 429, Vol. 32, Part 2, in the article dealing with the British Tariff Commission and the machinery trade in England an obvious error occurred in misnaming the two tables. The figures given above Table 2 should have gone above Table 1, and *vice versa* and in like manner the captions of the tables were interchanged.

New Publications

ELEMENTARY PRINCIPLES OF INDUSTRIAL DRAWINGS. By George Jepson. Cloth; 29 6x8-inch pages; 11 full-page plates.

This little book is intended to present to the student the essential principles of mechanical and architectural drawings, and is made up largely of exercises given by the author in a course of lectures. It deals mainly with the principles of projection, sections of cones, cylinders and spheres, and development of conical surfaces. The application of the principles of projection to mechanical drawing is illustrated by two plates of drawings of connecting rods.

LEÇONS, SUR LES ALLIAGES METALLIQUES (LESSONS ON METALLIC ALLOYS). By J. Cavalier. Paper; 480 pages; 6½x10 inches; 124 illustrations in the text and 24 metallographical plates. Published by Vuibert & Nony, 63 Boulevard Saint-Germain, Paris. Price, 12 francs.

This volume on the "chemistry of solid bodies," to borrow a term employed in the preface, is large enough to give an impression, on first taking it up, that it contains an exhaustive treatise. But the author disclaims attempt to cover the alloy field in such a manner as has been done by M. Guillet. His method is to explain the principles of alloys in general, elementary enough for readers with slender knowledge of physical chemistry, which, indeed, he builds up from its foundation, and to follow this with a discussion of some important alloys. The first part is occupied in explaining the physical and other properties of metals; the preparation of alloys, melting, cementation, reduction, refining, electrolysis and casting; their constitution, chemistry and microscopical study; their solidification and fusion; transformations and heat treatment; pyrometry; physical and mechanical properties. The last head furnishes opportunity to describe methods of testing. The specific alloys studied in the second part are selected with a view to their industrial interest and with an attempt to typify the more important groups of alloys. They are arranged beginning with the simpler and passing to the more complex. These groups are substantially as follows: Alloys of gold and silver; of lead, tin, antimony and bismuth; copper and deoxidants; ordinary and special bronzes and brasses; aluminum; nickel; anti-friction metals; common and special steels. To special steels about 40 pages are devoted and in connection with them some reference naturally is made to heat treatment. Study of alloys has made great progress in late years, their industrial applications being coördinated with laboratory investigations on a scientific basis. M. Cavalier's book summarizes the results in a branch of knowledge which is distinctly modern.

Personals*

Following the resignation of R. E. De Weise, John W. Good has been elected treasurer of the Lucas Pump Company, of Dayton, Ohio.

A. W. Lewin, for some time connected with the New Orleans office of the Sprague Electric Company, was recently made manager of that office.

James H. Norris, for a number of years business manager of the John F. Allen Riveting Machine Company, New York City, has recently resigned his position.

Alex Brain, formerly assistant factory superintendent of the Burroughs Adding Machine Company, has been made factory superintendent to succeed F. R. Heym, recently resigned.

C. Booth, formerly with the Remington Typewriter Company, Ilion, N. Y., is now connected with the Standard Roller Bearing Company, Philadelphia, Penn., as superintendent of the axle plant.

Herman Riecke, of Schuchard & Schütte, Vienna, has arrived in this country, and will make an extensive trip through the United States visiting the different manufacturers that his company represents.

Frank Salomon, of the engineering staff of Alfred H. Schütte, Cologne, Germany, is at present in this country and can be reached by addressing him in care of Alfred H. Schütte, West Street building, New York City.

W. J. Hower, for a number of years general foreman at the Chicago and Hawthorne plants of the Western Electric Company, has resigned to accept a position with the Automatic Electric Company, Chicago, Ill., as general foreman of the insulating and assembly departments.

Charles M. Robertson, formerly superintendent and boring-mill expert of the Colburn Machine Tool Company, Franklin, Penn., is now associated with the E. S. Essley Machinery Company, Chicago and Milwaukee, and will devote his time exclusively to the handling of Colburn mills.

W. J. Tewksbury, for many years employed by the Western Electric Company, of Chicago, as chief inspector, and more recently as general foreman of machine and assembly departments, recently accepted the position of shop superintendent with the Automatic Electric Company, Chicago, Ill.

F. R. Heym, for several years factory superintendent of the Burroughs Adding Machine Company, resigned his position recently to become an active member of the firm of Schweppe & Wilt, Detroit, Mich., manufacturers of automobile parts. Upon his leave Mr. Heym was presented with a gold watch by the foremen of the Burroughs plant.

*Items for this column are solicited.

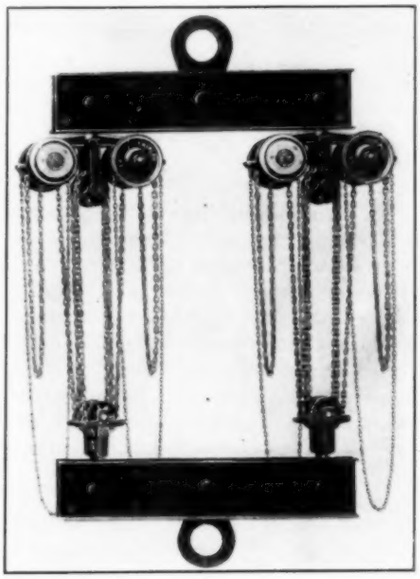
New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Triplex Chain Block of 40 Tons Capacity

As our readers are aware, the Yale & Towne Manufacturing Company, New York City, has regularly for years made its Triplex chain blocks up to 20 tons capacity. The 40-ton Triplex illustrated herewith has recently been developed to meet the demands for a hand hoist to handle very heavy loads where the installation of an electric crane or powerful steam hoist, because of time or cost, would be out of the question. The 40-ton Triplex is composed of two 20-ton units with equalizing bars at top and bottom. This provides for single-point suspension and for a single point for attachment of load. The equalizing bars are made of two channels placed back to back with separators. Provision is made for the swiveling of each unit at top and bottom. The clevises or points of attachment enable the user to easily put the hoist in place wherever used, and also afford a convenient point for the attachment of the load. It is especially

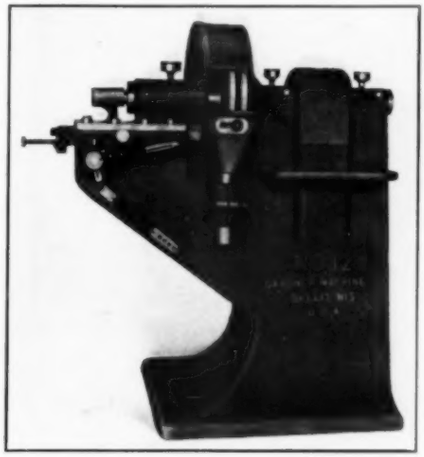


40-TON TRIPLEX CHAIN BLOCK

adapted for use in wrecking work (especially marine); in manufacturing plants; at mines and quarries and in building operations, and generally for loading and unloading. It may be installed over railroad tracks on a properly guyed temporary or permanent trestle. Lateral motion may be secured by one or more trolleys running on a large I-beam. It is available for handling heavy ordnance, etc., where head room, cost, infrequency of lift, or other conditions do not permit the use of power cranes of sufficient capacity. The hand chains are arranged to permit two, four, or eight men to work effectively. Where the load is larger than 40 tons it is generally of sufficient size to permit two of these hoists to be worked together, giving a total capacity of 80 tons.

A Disk Grinder with Underbelt Drive

For the purpose of overcoming the difficulties encountered in direct motor-driven disk grinders where the armature shaft



BELT-DRIVEN DISK GRINDER

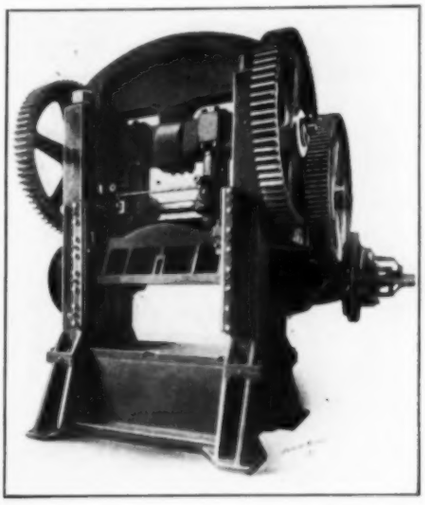
serves also as the spindle of the machine, the Gardner Machine Company, of Beloit, Wis., has designed a new arrangement for belt drive, as shown in the halftone.

The dust problem is ever present in the direct motor-driven disk grinder, and the end play of the armature shaft, required for magnetic balance, makes it difficult to accomplish accurate results.

The cut shows an under-belt drive as applied to a plain disk grinder. Arrangement is made whereby the belt passes over the machine-spindle pulley, down through the base of the machine and floor to the motor mounted on the ceiling or a pedestal below. The pulley and belt are entirely inclosed and the machine is a compact and efficient substitute for the direct motor driven disk grinder.

A Double Crank Press

The machine shown is designed for heavy cold bending, drawing and forming operations in the manufacture of articles of large dimensions from thick sheet steel, such as automobile-engine crank cases, frame members, channels, etc.; also for



A DOUBLE CRANK PRESS

heavy cutting and perforating and all general purposes for which presses of great power and wide dimensions between the frame columns are necessary or convenient.

The machine shown can exert a safe working pressure of 800 tons. The driving power is applied at both ends of the crank shaft, there being a large gear on each end of the shaft, thus dividing the bending and torsional strains over both ends of the crank shaft, relieving one crank of the duty of driving the other, also greatly moderating the pressure on the main journals and the large gear teeth. The pressure exerted by the machine is borne by four steel tension rods extending from underneath the ends of the bed through the bed, frame columns and crown piece, binding these four members together. The bases of the columns are bolted and doweled to the bed independent of the tension rods, to secure ample rigidity for the resistance of side strains.

The guiding ways in the frame columns are heavily gibbed and adjustable from the front to preserve alinement and compensate for wear. Provision is made in the slide, bed and columns for the application of direct knockout rods, also

front and back knockout bars. The pitmans are designed with very large wearing surfaces; they are provided with screw adjustment so connected that the two pitmans are adjusted up or down simultaneously insuring the keeping of the lower surface of the slide parallel with the bed of the press. The crank shaft is made of high-carbon open-hearth steel. The center bearing of the crown piece for receiving the upward pressure between the two cranks, is strongly capped to receive downward pressure due to operations that involve heavy stripping. The gear wheels are of cast steel; the pinions of forged steel; the teeth in both being machine cut.

The machine is controlled by a hand lever operating a combined friction clutch and brake.

The flywheel, which also serves as a driving pulley, is not keyed directly to the shaft, but is connected to a safety coupling of improved design so that by the shearing of a safety bolt the flywheel is permitted to revolve idly in case of the press being subjected to a pressure greatly exceeding that for which it is intended, also overcoming the liability of breaking the press if through neglect or oversight a hammer, monkey wrench, or some other article is left on the press in position to interfere with its working.

The following are some of the principal dimensions of the machine: Width between frame columns, 74 inches; width between gibs, 67 inches; stroke of slide, 14 inches; distance from bed to slide, stroke down, adjustment up, 20 inches; adjustment of slide, 6 inches. The flywheel is 48 inches diameter with 12½ inches face, weighs about 3500 pounds, and makes 280 revolutions per minute. The total weight of the machine as shown is approximately 98,000 pounds. It is made by the E. W. Bliss Company, 1 Adams street, Brooklyn, N. Y.

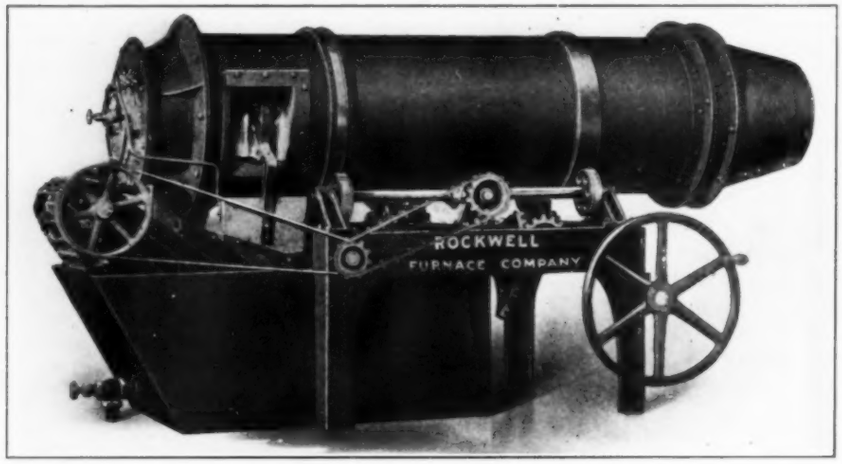


FIG. 1. AUTOMATIC AND ANNEALING FURNACE WITH TILTING MECHANISM

Continuous Annealing and Hardening Furnaces for Gas or Oil Fuel

The Rockwell Furnace Company, 26 Cortlandt street, New York, have recently improved their well known type of internally fired rotary furnace, which gives a great flexibility in range of work handled by it, and greatly adds to its durability.

Heretofore these furnaces were built only with special lining brick, which formed deep helical channels with separating spiral walls for feeding the material forward. This arrangement worked very well for light smooth pieces, such as lock washers, balls, etc., and is still spirally lined for this class of work, but was found to be unsuitable for long pieces, such as bolts, rivets, etc., and irregular-shaped steel punchings, forgings, castings, etc., and other methods of feeding the material through the furnace were required.

In the present type of furnace, for smooth or round work, the rotating cylinder or drum is lined with a standard hard refractory brick, with a smooth internal surface. The furnace is mounted in such a manner that its axis may be tilted at an angle giving the revolving hearth an incline with the discharge end lower than the entrance or feed end. The gradual incline causes the material to feed forward, and by means of a handwheel the degree of pitch may be adjusted so as to regulate the progression of the material through the furnace and consequently the time of heating.

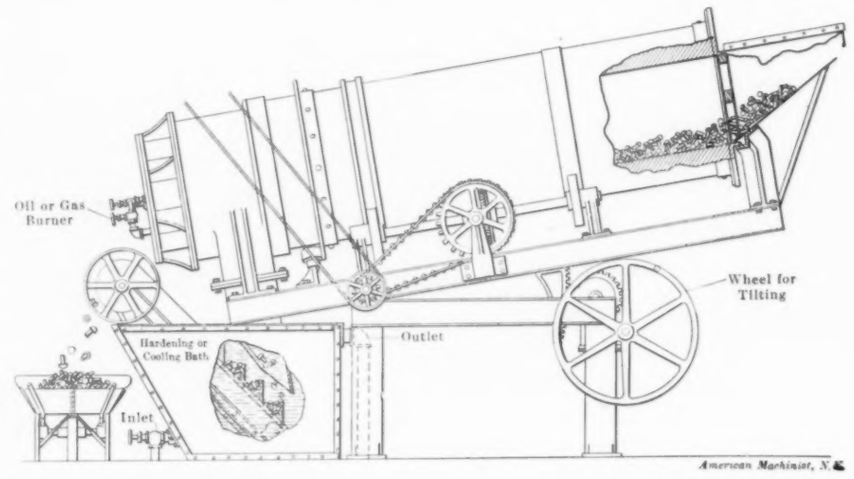


FIG. 2. AUTOMATIC FURNACE WITH INCLINING ATTACHMENT AND SMOOTH INTERIOR

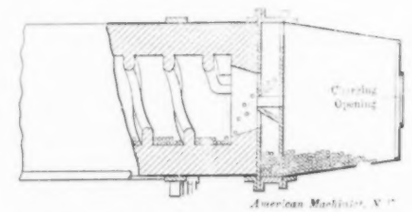


FIG. 3. FURNACE WITH HELICAL OR WORM INTERIOR

The advantages of this method of automatic continuous heating are many: The material is charged in a hopper in bulk at one end of the furnace and fed automatically into the chamber and it comes continually in contact with the newly heated interior surface, which is revolving, thereby absorbing the heat from the lining as well as from the heated gases. In a stationary furnace the heat from the sides and roof are not utilized, as the material remains in a fixed position; that farthest removed from the heat requires a much longer period to be brought to the desired temperature and the more exposed pieces are liable to overheating, while others are insufficiently heated.

Tests of material being heated and hardened in the internally fired rotary furnaces, shown in Figs. 1 and 4, at the rate of 2000 pounds per hour, have failed to show the slightest variation. With a pyrometer to insure the proper temperature and the chamber tilted to feed at the proper speed the product must be absolutely uniform.

In operation, the pieces are fed continuously into one end of the cylinder. The furnace is fired internally from the opposite end with the zone of highest temperature at the discharge end. The cylinder revolves slowly (1 to 4 revolutions per minute) and owing to the slight inclination of the furnace, the pieces treated fall slightly forward at each revolution, gradually progressing toward the discharge end, where they enter a proper receptacle or bath upon reaching the desired temperature.

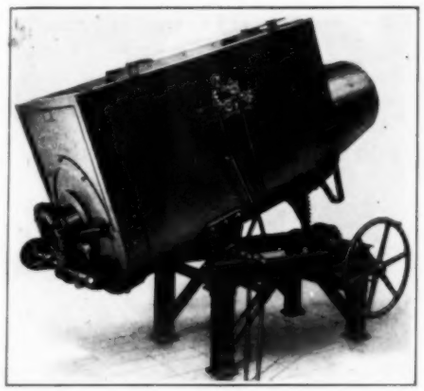


FIG. 4. ANOTHER TYPE OF INCLINING AUTOMATIC FURNACE

To prevent oxidation, the end of the discharge spout may be carried beneath the level of the bath, thereby sealing it and excluding the air.

By this method, clogging or retardation of the work is avoided, as there are no corners or pockets in which the pieces can lodge. Wear of the lining is reduced to a minimum and does not require renewal until the greater portion of the brick is worn away. In certain classes of work, such as balls, nuts and uniform shapes, the helical or worm type, as shown in Figs. 3 and 5, is used. These furnaces may be lined either way, as preferred, but

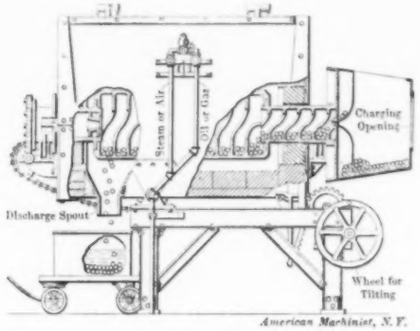


FIG. 5. SECTIONAL VIEW OF FURNACE IN FIG. 4

where the smooth lining can be used the cost is less and a greater life is insured.

Oil or gas fuel may be used, and perfectly uniform results obtained, as the work treated is heated gradually with every portion of its surface exposed to the direct action of the hot gases and lining, and both temperature and time are maintained constant.

These furnaces are built to suit a wide range of requirements, and in sizes at present that will handle up to 2000 pounds of stock per hour.

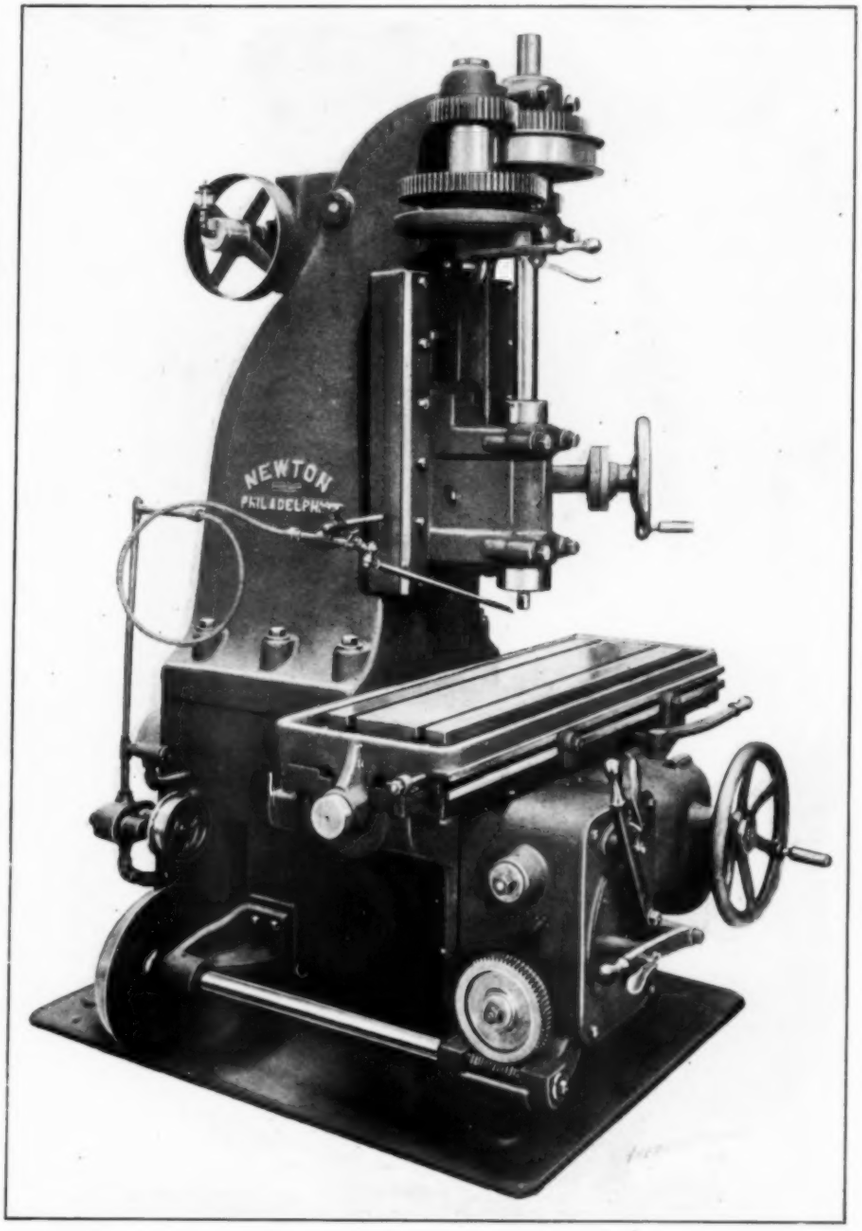
In Fig. 1 is shown the furnace with a quenching bath into which the work drops directly from the furnace. This quenching tank contains an automatic conveyer that lifts the work out of the tank and dumps it into a wheel-barrow, as shown in Fig. 2. This is an extra which may or may not go with the furnace as desired.

By Fig. 2 are shown the details of the furnace as supplied with a smooth lining and Fig. 3 shows the helical or worm lining that can be used with the same furnace if desired.

In Fig. 4 is shown a furnace that is built on the same principle, with the exception that the work is held in a revolving retort and the heating gases surround this in such a way that they do not come in contact with the work. In Fig. 5 are shown the details of the construction of this furnace.

A Vertical Keyseat Milling Machine

The halftone shows a new design of vertical milling machine which is intended particularly for keyseating. The spindle



A VERTICAL KEYSEAT MILLING MACHINE

of this machine is mounted in a bronzed bush bearing in the saddle, which is vertically adjustable, giving a minimum distance from the bottom of the spindle to the top of the work table of 6 inches and a maximum distance of 18 inches. The vertical adjustment is obtained by a sta-

tionary screw upon which is mounted a nut which is operated by the handwheel, shown above the table. The spindle speeds are from 142 to 395 revolutions per minute when driving with the back gears in, and from 430 to 1194 revolutions per minute

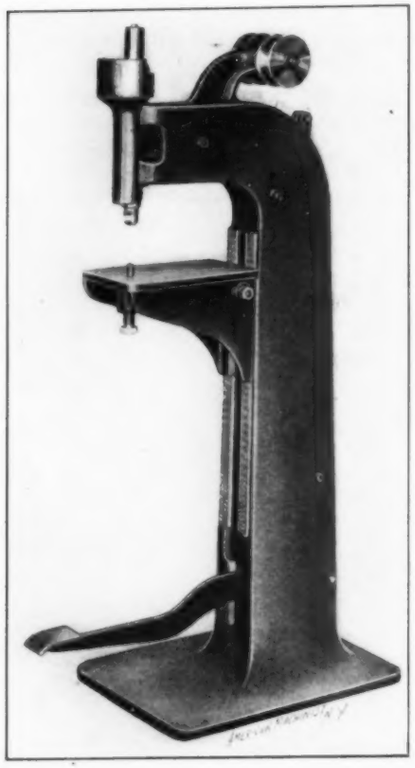


FIG. 1. RIVET-SPINNING MACHINE

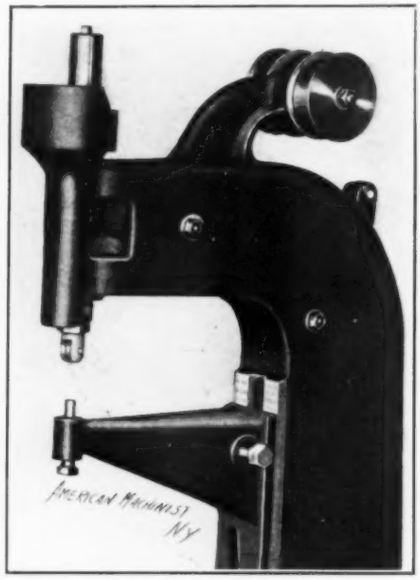


FIG. 2. RIVET-SPINNING MACHINE WITH HORN TABLE

when driving direct with the back gears out.

The work table is 11 inches wide by 40 inches long, and is surrounded by an oil pan. The carriage has 36 inches of automatic power feed in either direction. The motion for the feed is through the worm wheel, shown on the side of the feed box in which nine gears are mounted, giving nine changes of feed. Release to the feed is obtained by the adjusting dogs, shown on the side of the table. The machine occupies a floor space of about 4x5 feet. During preliminary tests 1-inch keyseats were milled at a speed of 3 inches per minute, the entire depth being taken at one cut. This machine is built by the Newton Machine Tool Works, Inc., Philadelphia, Penn.

Rivet Spinning Machines

The illustrations show two types of rivet-spinning machines built by the Grant Manufacturing and Machine Company, Bridgeport, Conn. With these machines the heads are formed on the rivets by a rolling process and under pressure. The vertical type of machine is shown in Fig. 1, which illustrates clearly the method by which the spindle is driven and also the treadle by which the riveting roll is brought down onto the work. This type of machine will rivet up to 11½ inches from the edge of the work, and the three sizes in which it is made have a capacity for 3/16-, ¼- and ⅜-inch rivets, respectively. The machine is fitted with either a flat table, as in Fig. 1, a horn table, as in Fig. 2, or with both tables if required. The dimensions of the table in Fig. 1 are 8 inches wide by 14 inches deep. The double-spindle machine in Fig. 3 is designed for handling work where both ends can be riveted at the same time. The frame has a finished surface on top between the spindles and also at the front, so that fixtures or a small table for holding the work may be readily attached. The machine is operated by a treadle attached to the floor and connected underneath the machine, out of the way of the operator. Although the illustration shows the machine as built for bench use, it can be mounted on a pedestal if desired. This machine has a capacity for rivets up to ⅛-inch diameter. The maximum capacity between spindles is 1½ inches. The distance from frame to spindle center is 2⅝ inches.

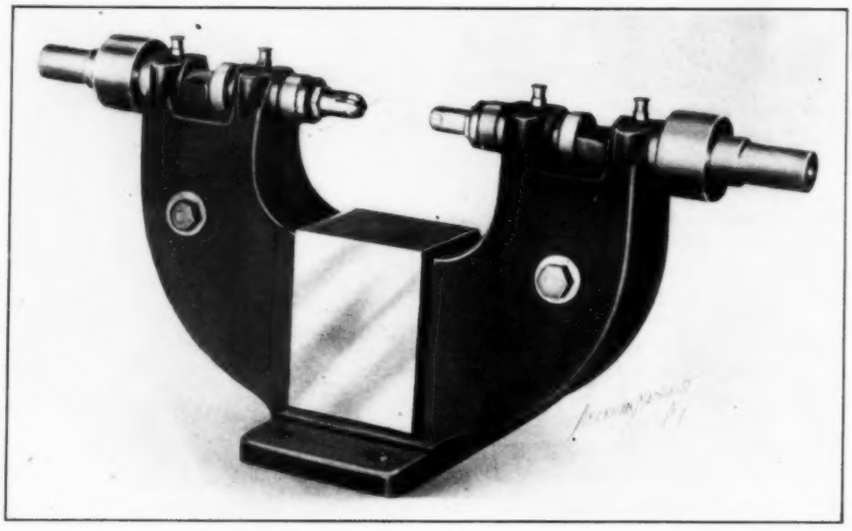


FIG. 3. DOUBLE-SPINDLE RIVETING MACHINE

Slotting Attachment for the Automatic Screw Machine

By C. Nosrac

This attachment was designed for the purpose of cutting a 0.01-inch slot, 5/32 inch deep in the small end of taper dowel pins, large quantities of which are used in the manufacture of a well known mechanical product. Owing to these pins being turned with the small end at the right, and the slot being required in this end, it was impracticable to handle them in the regular screw-slotting attachment furnished with the Brown & Sharpe machines, as it would be necessary to turn the pin end for end before slotting.

We therefore decided to slot them in the collet before tapering and then taper and cut off afterward. This was accomplished in the following manner: The hole in the standard turret shaft was fitted with bronze bushings about 1½ inches long, at the front and rear end, and a steel shaft was then turned to fit the bushings, and provided with a bevel gear turned on the turret end, which will be seen in the turret recess, in Fig. 1. The other end of this shaft carries a pulley having a V groove for a round belt and is driven from a similar pulley on the overhead counter-shaft.

The turret hole marked No. 1 was fitted with a bronze bushing, and in this is run a short shaft having a bevel gear turned integral on the left-hand end, while the right-hand end is screwed into

a bevel gear in the turret recess, which meshes with the gear on the driving shaft. The gears in the turret recess are covered with a brass cap which serves to prevent chips from the taper tool entering and wedging them. A steel bracket is mounted on the turret as shown, by securing it to two round plugs which are clamped in the regular tool holes No. 2 and 6. This bracket is made in two parts, and doweled and screwed together in order to permit assembling of the saw-clamping device. This bracket is provided with a removable block on the extreme outer end which carries the supporting

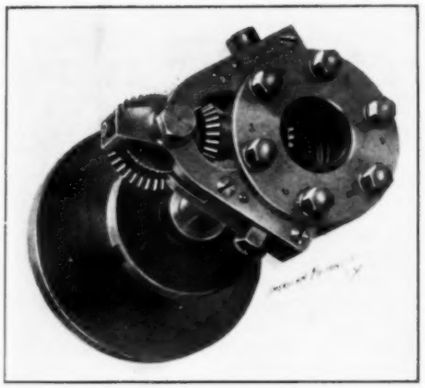
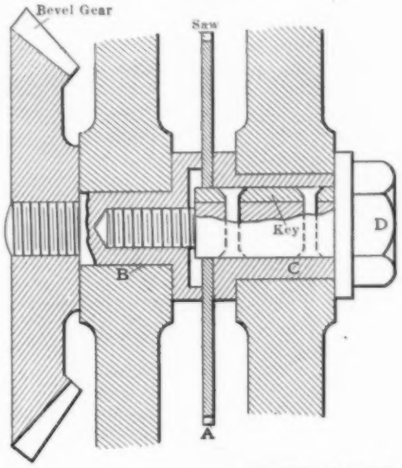


FIG. 1. SLOTTING ATTACHMENTS FOR BROWN & SHARPE AUTOMATIC SCREW MACHINE



American Machinist, N.Y.

FIG. 2. SECTION THROUGH SAW ARBOR AND BRACKET FOR SLOTTING ATTACHMENT

bushing to hold the stock while slotting. Through the bosses of the bracket runs the saw arbor, carrying at its rear end a bevel gear which meshes with the smaller gear on the short shaft through the turret hole, shown in the halftone. The rotary motion is thus imparted to the saw without preventing the revolving of the turret in the regular way.

The method of clamping the saw is shown in the sketch, Fig. 2, in which *A* is the saw, *B* the bevel-gear stud, *C* the clamp bushing, *D* a clamp screw provided with a flat key that fits a keyway in *C* and also in the saw. It will be seen that the end *B* next to the saw is recessed enough to allow the shoulder of *D* and the end of the key to project through the saw, and permit of the saw being tightly clamped between the hubs.

The turret is provided with a feed stop, and a taper tool, and the cross slides carry a cut-off tool and taper-tool wedge. The belt is removed from the forward pulley of the screw-machine spindle, and a band clamp placed around this pulley to prevent its rotation, yet allowing it to slip a trifle when the cam trips the clutch from the rear pulley to the front one. This causes the spindle to stop instantly and holds the work stationary while the saw on the turret approaches and slots the end of the stock.

The operation of the machine is as follows: The stock feeds to the stop, the turret indexes twice to the saw and the spindle clutch trips to the front pulley, stopping the rotation of the stock; the saw approaches and slots the end of the stock and backs away, the spindle clutch trips back to the rear pulley putting the stock in rotation; the turret indexes twice to the taper tool, then approaches turning the taper, and backs away, the cut-off tool cuts off the finished pin, the turret indexes to the stop pin and the operations start as before. The output is approximately 450 per hour.

Although in its infancy the influence of airship development has already been felt in other lines of industry. Probably its first and most important influence has been the demand it has created for a lightweight engine capable of high driving power, and this in turn has led to the demand for the lighter materials of construction possessing exceptionally strong wearing qualities. While only a few names stand out prominently in the development of aërial navigation there are many thousands experimenting with different forms of airships and devices connected with them, as the patent office records show that 49 letters of patent on airships and airship devices were actually granted in this country in the year 1908. This means that many hundred applications have been made, and points to the fact that thousands of inventors and mechanicians are actively engaged in this new development. Although the most sanguine of airship enthusiasts cannot hope for an influence in the industrial world paralleling that of the automobile, they point to it as an example of what even the brief period of ten years' development can bring.

Forthcoming Meetings

National Machine Tool Builders' Association, fall meeting, October 12 and 13, New York City. P. E. Montanus, secretary, Springfield, Ohio.

National Society for the Promotion of Industrial Education, annual convention, December 1, 2 and 3, Milwaukee, Wis. J. C. Monaghan, secretary, 20 West Forty-fourth street, New York City.

Business Opportunities

The Somerville (N. J.) Iron Works is building a new foundry.

The Titusville (Penn.) Forge Company is extending its plant.

The Sterling Paper Company, Hamilton, Ohio, is enlarging its plant.

The Athol (Mass.) Pump Company is erecting two additional buildings.

The Valdosta (Ga.) Iron Company, a new concern, will erect a foundry.

The Peters Pump Company, Kewanee, Ill., is erecting a two-story addition.

The Missouri Car Company, St. Louis, Mo., will erect a three-story addition.

The Buffalo (N. Y.) Bronze Company, recently incorporated, is looking for a site.

The La Porte (Ind.) Door and Sash Company will build an addition to its plant.

Fire destroyed the plant of the Nevada (Iowa) Electric Company. It will be rebuilt.

The Standard Box Company, Baton Rouge, La., will erect an addition to its plant.

The Fall River (Mass.) Iron Works Company is erecting an addition to its No. 7 mill.

The Pacific Metal Works, Portland, Ore., will build a new foundry and warehouse.

The George L. Belcher Last Company, Stoughton, Mass., will build a three-story addition.

The Pennsylvania Iron Company will install a steam turbine at its mine in Vulcan, Mich.

The W. A. Slater Motor Company, Kansas City, Mo., has started the erection of a plant.

The Baltimore (Md.) Optical Company will build a new four-story manufacturing building.

The Niagara Pulp Board Company, Niagara Falls, N. Y., will rebuild plant recently burned.

The Rose Bus Company, Cleveland, Ohio, manufacturing wrought iron, will erect a new plant.

The Fremont (Neb.) Foundry and Machine Company has purchased a site for an additional building.

The Greer Iron Works, Greer, S. C., recently incorporated, will erect a foundry. B. F. Reese, president.

The plant of the Kelly Canning Company, Waverly, Iowa, recently destroyed by fire, will be rebuilt.

Wright & Hanford, Chicago, Ill., contemplate the erection of a $200,000 paper mill at Hattiesburg, Miss.

The Houlton Woolen Mill Company, Augusta, Me., is erecting an addition to be three and a half stories.

The Pittsburg (Penn.) Forge and Iron Company has contracted for the erection of a new forge shop.

The C. A. Stickney Company, St. Paul, Minn., manufacturer of gasolene engines, will erect a new foundry.

The Spicer Universal Joint Manufacturing Company, Plainfield, N. J., is building a new power house.

It is reported that the Monticello (Ark.) Cotton Mills is interested in a plan to establish another cotton factory.

P. Derby & Son, New York, furniture manufacturers, will erect a $94,000 factory building in Jersey City.

The plant of the Prizer-Painter Stove Company, of Reading, Penn., was burned. Loss, about $30,000.

The W. H. White Lumber Company, Boyne City, Mich., has built an addition and will install a new engine.

The Johnson Wood Finishing Company, Racine, Wis., expects to install individual motor for its machines.

Preparations are being made for the erection of three engineering shops for the Iowa University, Iowa City.

The Sea Isle City (N. J.) Electric Light, Power and Water Company will increase the capacity of its power plant.

It is reported the Morley Button Manufacturing Company, Portsmouth, N. H., will build an addition to its plant.

The Transue & Williams Company, Alliance, O., drop forgings manufacturer, is erecting an addition to its plant.

The B. & M. Machine Company, Akron, Ohio, recently incorporated, will build a plant. K. L. Meredith is president.

The Southern Stove Company, Evansville, Ind., has started the erection of a new plant. This is to cover several acres.

The N. Y. Belting and Packing Company, of New York, has let a contract for the erection of a plant in Passaic, N. J.

The K. H. Wheel Company, Detroit, Mich., is erecting an addition to its plant and is having plans drawn for another.

The Evansville (Ind.) Ice and Cold Storage Company has rebuilt its boiler room and will install a mechanical stoker.

The Miami Valley Knitting Mills, Hamilton, Ohio, is enlarging its plant. The firm will install more boilers, it is said.

The planing mill and furniture factory of George W. Dana, Camden, N. J., was destroyed by fire. Loss, about $10,000.

The Smith Machine Company, Milwaukee, Wis., will build an addition to its main machine shop. New equipment will be needed.

The Evansville (Ind.) Manual Training School will install modern equipment in machine shop and woodworking departments.

The Progressive Metal and Refining Company, Milwaukee, Wis., has had plans prepared for a new plant to cost about $50,000.

The Ivanhoe Manufacturing Company, Smithfield, N. C., has started the erection of a mill for the manufacture of hosiery yarns.

The Dothan Variety Works, Dothan, Ala., will rebuild its plant, recently burned. The company manufactures sash, doors, etc.

The D. H. Stoll Company, Buffalo, N. Y. manufacturing presses, dies and stamping machinery, will erect a two-story addition.

Fire destroyed the sawmill, electric-light plant, box factory, blacksmith shop and grist mill of the Campbell Lumber Company, Weymouth, N. S.

The H. E. Wilcox Motor Car Company, Minneapolis, Minn., has reorganized and will erect a new factory to be equipped with modern machinery.

The Sun Manufacturing Company, Columbus, Ohio, will erect a new and larger plant for the manufacture of coffee mills, show cases, lawn swings, etc.

The St. Louis (Mo.) Carbonating and Manufacturing Company will erect a three-story addition to its bottling plant, the machinery to cost $25,000.

Michael Blasberg & Co., Turners Falls, Mass., whose brass foundry was damaged by fire, have made a contract for the construction of a new fireproof brick foundry.

The Cleveland Cliffs Iron Company, of Cleveland, Ohio, is erecting a new machine shop, carpenter and blacksmith shops, engine room, etc., at its North Lake mine, near Ishpeming, Mich.

The De Haven Manufacturing Company, 50 Columbia Heights, Brooklyn, N. Y., is rebuilding its plantd estroyed by fire some time ago. The company's product is bale tires, pail hooks, iron box strips, etc.

The Breitung Hematite Mining Company, Negaunee, Mich., has erected a machine shop at the Mary Charlotte mine and is in the market for equipment. They will also be in the market for boiler house equipment, including two boilers, feed pump, etc.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: September 21—Appliances for use with oxygen-acetylene welding plant (schedule 1667), aluminum, steel bar (schedule 1663); brass, steel roof trusses (schedule 1659); steel angles (schedule 1679), solder (schedule 1677), steel tubes (schedule 1674), bolts, nails (schedule 1668); brass bolts (schedule 1661). September 28—Portable forges, annealing furnace (schedule 1669); bolts, nuts (schedule 1642); drills, wrenches (schedule 1640). October 5—Steel tanks (schedule 1670), boiler tubes (schedule 1678), magnet wire (schedule 1671), crane (schedule 1625), machines for making concrete blocks (schedule 1682), steam driven ice machine (schedule 1627), motor driven lathe (schedule 1685), motor driven pumps (schedule 1686), oxygen-acetylene welding appartaus (schedule 1684).

New Incorporations

Travella Shuttleless Loom Company, Boston, Mass. Manufacture looms and machinery. Capital, $150,000. H. Chiariglione, president.

Secor Typewriter Company, Derby, Conn. Capital, $30,000. Incorporators, D. S. Brinsmade, Shelton, Conn.; Charles N. Downs, Derby, etc.

Motor Service Company, Camden, N. J. Manufacture vehicles. Capital, $100,000. Incorporators, H. L. Lechner, Doering Bellinger, W. G. Jones.

The H. J. Martin Forging Company, Indianapolis, Ind. Manufacture drop automobile and special forgings. Capital, $75,000. H. J. Martin, president.

Rainer Motor Truck Company, New York. Manufacture motor trucks. Capital, $50,000. Incorporators, P. N. Lineberger, G. C. Comstock, J. T. Rainer.

The Universal Roller Bearing Company, Portland, Me. Manufacture and deal in roller bearings, etc. Capital, $10,000,000. Albert J. Jones, Portland, president.

Modern Art Lamp Works, Perth Amboy, N. J. Manufacture gas and electric fixtures, etc. Capital, $50,000. Incorporators, Adolph Scheadow, S. Spitzer, H. Ellis.

Saltzman Manufacturing Company, Chicago, Ill. Manufacture machinery. Capital, $30,000. Incorporators, George A. Chritton, Joseph Saltzman, Harry A. Williams.

Manhattan Railway Supply Company, New York. Manufacture railway supplies. Capital, $110,000. Incorporators, A. J. Hammerslough, A. L. Strasser, L. M. Wallstein.

Republic Elevator and Machine Company, Rochester, N. Y. Manufacture machinery, elevators, tools, etc. Capital, $30,000. Incorporators, F. A. Stoffel, G. H. Fegan, H. L. Morgan.

Supply and Construction Corporation, Morristown, N. J. Manufacture gas and oil machines. Capital, $125,000. Incorporators, J. B. Headley, Morristown; O. Kuester, Hoboken; H. Potze, Brooklyn, N. Y.

The Hawthorne Manufacturing Company, Bridgeport, Conn. Manufacture automobile accessories. Capital, $50,000. Incorporators, John H. George, Bridgeport; S. H. Creighton, Rockville Centre, N. Y., etc.

National Typecasting Machine Company, New York. Manufacture typesetting machines. Capital, $100,000. Incorporators, M. G. Bender, B. M. Cooke, 34 Nassau street; K. R. Norton, 26 Liberty street, New York.

New Catalogs

Keuffel & Esser Company, Hoboken, N. J. Circular of blue print papers.

Wells Bros. Company, Greenfield, Mass. Circular descriptive of taps, dies and screw plates made in A. S. M. E. standards.

The Champion Tool Works Company, 2420 Spring Grove avenue, Cincinnati, Ohio. Loose-leaf catalog of lathes. Illustrated, 6x9 inches.

Woburn Gear Works, 32 Nashua street, Woburn, Mass. Catalog of gears, sprockets, chains, etc. Illustrated, 12 pages, 5x8½ inches, paper.

The Graham Manufacturing Company, 94 Point street, Providence, R. I. Circular illustrating and describing pressed steel grinder chucks.

Newman-Andrew Company, 107 West street, New York. Catalog of Toledo high speed steel, tool steel, etc. Illustrated, 18 pages, 3½x8 inches, paper.

United Engineering and Foundry Company, Pittsburg, Penn. Catalog describing high speed steam-hydraulic forging press. Illustrated, 22 pages, 7½x10½ inches.

The Cincinnati Electrical Tool Company, Cincinnati, Ohio. Catalog of Peerless portable electric drills, reamers and grinders. Illustrated, 44 pages, 6x9 inches, paper.

American Tap and Die Company, Greenfield, Mass. Catalog No. 3 of screw plates, taps and dies, stocks and tap wrenches, etc. Illustrated, 72 pages, 6x9 inches, paper.

Schaap Flame Utilities Corporation, 344 Cumberland street, Brooklyn, N. Y. Catalog describing Schaap process of autogenous welding. Illustrated, 10 pages, 6x9 inches.

W. F. & John Barnes Company, Rockford, Ill. Catalog No. 69, describing upright drills, water emery grinder, screw press, gang drills. Illustrated, 72 pages, 6x9 inches, paper.

National File and Tool Company, 2110 Allegheny avenue, Philadelphia, Penn. Catalog describing Vixen hand milling tools. Illustrated, 24 pages, 4½x7 inches, paper.

Radical Angular Drill and Tool Company, 119 W. 23d street, New York. Catalog describ, ing Radical angular drilling attachment. Illustrated, 12 pages, 6½x9½ inches, paper.

The Triumph Electric Company, Cincinnati, Ohio. Bulletin No. 371, describing adjustable speed commutation pole motors for driving machine tools, etc. Illustrated, 12 pages, 7x10 inches.

Coates Clipper Manufacturing Company, Worcester, Mass. Bulletin No. 22, describing flexible shafts, grinding heads, angle drive, polishing outfits, chipping hammers, etc. Illustrated, 66 pages, 6x8½ inches, paper.

General Electric Company, Schenectady, N. Y. Bulletin No. 4675, illustrating and describing single-phase motors, Type RI. Bulletin No. 4677, illustrating and describing Sprague-General Electric type M control system.

The Heald Machine Company, Worcester, Mass. Catalog describing American drill grinder. Illustrated, 20 pages, 6x9 inches, paper. Catalog describing Heald cylinder grinder and ring and surface grinder. Illustrated, 36 pages, 6x9 inches, paper.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number.

Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E. G. Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

First-rate German house wishes offers for vulcanized fiber. Answers to K. U. 8424, Rudolf Mosse, Cologne-on-Rhine, Germany.

Dies designed, all kinds, with cost of making; practical working drawings; send sketch of model. Box 548, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Machinists and engineers blueprint chart of United States Standard pipes and tapping sizes from ¼" to 10" pipe. Price 10 cents per copy postpaid. Liberal discounts to shop agents. Address Charles Kuderer, Woodlawn, Penn.

By manufacturer, agents or dealers to handle oil cup of improved design; excellent cup and can be sold at a low price; large field for the sale of this device among machine shops, mills, etc. For particulars address Box 612, AMERICAN MACHINIST.

We wish to become the sales agents for a few good lines of machinery or construction supplies for the territory covered out of Minneapolis; will consider nothing but the highest grade of goods; warehouse provided if desirable. Address Box 120, Minneapolis.

Wanted—Heald or Brown & Sharpe cylinder grinder in good condition. Also a multiple spindle drill or multiple spindle drill head, Baush, or a Pratt & Whitney preferred; eight to fifteen spindles for drilling ⅝ holes in aluminum and capable of 19-inch circle. State condition and name best price. The Jewel Carriage Company, Cincinnati, Ohio.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

General foreman or assistant superintendent, uptodate in modern shop methods, premium plan and piece work, at present employed, would like change. Box 665, AMERICAN MACHINIST.

ILLINOIS

Position wanted by an experienced superintendent, expert in machine work and manufacturing; a good organizer; resourceful in designs and processes for increasing production; location not material. Box 672, AM. MA.

Practical superintendent and works manager will be at liberty September 15; successful organizer, systematizer and manager with modern ideas of shop practice and economical production; familiar with foundry, machine, sheet metal, forge and wood working. Address, "Superintendent," 910 West California street, Urbana, Ill.

LOUISANA

Machine tool salesman of recognized ability would consider offer as representative in good territory, or as purchasing agent for large corporation; thorough practical and technical knowledge as well as commercial. Box 661, AMERICAN MACHINIST.

MASSACHUSETTS

Chief draftsman and practical designer; technical graduate; seven years' experience on steam engines and electrical machinery in general; desires permanent position. Box 632, AMERICAN MACHINIST.

MICHIGAN

Mechanical engineer, technical graduate, energetic, aggressive and systematic, 16 years' experience as designer, chief draftsman and engineer; conversant with both mechanical and structural work. Desires responsible engineering position with first-class firm. Box 586, AMERICAN MACHINIST.

NEW JERSEY

American, age 30, wishes outside position where a mechanical education, integrity and ability are essential. Box 662, AM. MACH.

Superintendent or general foreman; good organizer and executive; mechanically efficient; 15 years foreman, three years superintendent; machine tool and general experience; best references from present and former employers. Box 649, AMERICAN MACHINIST.

Wanted—Position, assistant to chief engineer, superintendent, or any position of trust; technical graduate, 25; seven years' practical experience, tools, dies, automatic machinery; now in responsible position; ambition and advancement reasons for desired change. Box 659, AMERICAN MACHINIST.

Responsible position wanted by thorough, hustling mechanic, with exceptional ability in designing and building of any kind of automatic machines, presses, dies and tools for the manufacturing of sheet-metal goods; 32 years of age; A-1 references from the largest firm in this line. Box 668, AM. MACH.

NEW YORK

Wanted—By experienced mechanical draftsman, position with well-established, growing concern; best references. Box 648, AM. MA.

Mechanical draftsman, young man, five years' shop and three years' drawing-room experience, desires position. Box 655, AM. M.

By mechanical engineer and draftsman; seven years' experience on automatic machinery, special tools, rolling mill machinery. Box 673, AMERICAN MACHINIST.

Designer of all kinds of special machinery, hydraulic machinery; also wide experience in developing inventions; references; interview, preferably in New York, or the East. Box 674, AMERICAN MACHINIST.

Wanted—By a general office man now employed by large manufacturing concern employing 4000 people, position as correspondent, credit man, or bookkeeper, with reliable manufacturer. Box 660, AMER. MACHINIST.

Technical graduate, 36, desires position as manager, assistant or superintendent; fifteen years' experience in shop, drafting room and office; capable designer of special tools and familiar with best systems of production and of cost accounting and factory maintenance. Box 657, AMERICAN MACHINIST.

OHIO

Works manager or general superintendent invites correspondence from reliable concerns wishing to secure the services of a high-class executive with a clean-cut record as an earning power. Address Box 654, AMER. MACH.

Up-to-date mechanical engineer, expert mechanic, designer and shop man, with quick comprehension, 13 years' vast experience in sheet metal working and automatic machinery, tools, dies for cheap and rapid production, accustomed to heavy responsibilities, wants position. Box 663, AMER. MACHINIST.

WISCONSIN

Man with 20 years' experience as superintendent and manager of large machine works is open for an engagement October 1. Applicant is fully qualified to assume entire charge of office and works as its official head. Have good executive ability, good organizer and can produce maximum amount of work at minimum cost. Box 666, AMER. MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted at once, an expert fitter on wood tools to take charge fitting department small progressive shop; must be of good education, understand drawings, jig and templet work; state references, age, habits and salary wanted. Box 669, AMERICAN MACHINIST.

CONNECTICUT

Wanted—A first-class toolmaker on jig and fixture work. Box 621, AMER. MACHINIST.

DELAWARE

Two expert all-round machinists and toolmakers wanted to work in a small shop that is equipped with the best machinery and tools, all new; must have ability and be thorough mechanics interested in doing nice work; age 30 to 40, married, permanent employment; exceptionally nice shop and location; good position for the right man and there is a good future. Box 658, AMER. MACHINIST.

ILLINOIS

Wanted—First-class designer capable of developing a line of high-grade machine tools; excellent opportunity for a young man of good character to broaden his reputation and better his position; applicant must have wide experience and be able to produce successful machines, that will compete with standard machines now on the market; for consideration give full information regarding present position, past experience and salary wanted; correspondence strictly confidential. Box 657, AMERICAN MACHINIST.

INDIANA

Two experienced foremen for machine and assembling rooms, manufacturing gasolene motors. Give reference, experience and age. Box 262, AMERICAN MACHINIST.

Wanted—Experienced operators for Brown & Sharpe automatic and Brown & Sharpe hand screw machines; highest wages for competent men. Box 656, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—First-class draftsman. Supervisor of Drafting Rooms, General Electric Co., Pittsfield, Mass.

Wanted—Well posted mill and machine shop supply salesman. Good opportunity for ambitious man. All communications strictly confidential. Address: The Fairbanks Company, Boston, Mass.

A firm located near Boston wants immediately a foreman assembler to take charge of six or eight men assembling light recording instruments; must have had a large and successful past experience, and must be accurate, decisive and capable of handling men to get results; state names of past employers and wages expected; good position for the right man. Box 647, AMERICAN MACHINIST.

Wanted—Thoroughly competent young man with some mechanical and executive experience to act as assistant superintendent in a small thoroughly equipped progressive factory manufacturing small tools, located in a large city in Western New England. Owing to certain conditions right man has an unusual opportunity for speedy advancement. In sending application state fully in detail all qualifications, for whom you have worked, present position, salary expected, etc. Box 638, AMERICAN MACHINIST.

MICHIGAN

Wanted—First-class milling machine and lathe hands; give age, experience and wages expected. Apply Buick Motor Co., Flint, Mich.

Wanted—First-class man to take charge of tool crib; state age, experience and wages expected. Apply Buick Motor Co., Flint, Mich.

Wanted—Man to take charge of twenty Jones & Lamson machines; must know the machine thoroughly. Weston-Mott Co., Flint, Michigan.

Wanted—First-class, all-round machinists; good wages and steady employment for competent men. Apply to Michigan Machinery Mfg. Co., Ypsilanti, Mich.

Wanted—Foreman for machine shop and repair department; must be capable of handling fifteen to twenty general machinists. Weston-Mott Co., Flint, Mich.

Wanted—Salesman to handle special machine tool in Michigan, Ohio and Indiana; somewhat acquainted with automobile manufacturers and their machine tool equipment; machine is already thoroughly introduced; state selling or other machine-tool experience. Address: "Salesman," Wayne Hotel, Detroit, up to September 22.

Wanted—By a large company, a man who is fully capable of designing A-1 tool equipments for turret lathes, such as Gisholts and similar machines, of which we have a large number. Applicant must be well posted on most effective methods of procuring results from turret lathes, and able to put his ideas to effective use; work will be steady and pay liberal to the right man; state qualifications fully. Box 625, AMERICAN MACHINIST.

MISSOURI

Wanted—Two all-round machinists (lathe hands preferred), and also one first-class milling machine hand on job work; steady work and good wages to the right man; open shop. Hugh Mathews, Kansas City, Mo.

NEW JERSEY

Wanted—Experienced operator for a Gisholt turret lathe. Address Trenton Engine Co., Trenton, N. J.

Wanted—Tool room foreman who thoroughly understands die work and building of special machinery and is capable of estimating costs; state age, experience and salary expected; A-1 references required. Box 620, AMERICAN MACHINIST.

NEW YORK

Mechanical engineer; technical graduate; young man, 19 to 24 years of age. Box 650, AMERICAN MACHINIST.

Wanted—Mechanical draftsmen, experienced in electric traveling crane designing. Box 633, AMERICAN MACHINIST.

Wanted—Automatic screw machine operators, man with experience on Brown & Sharpe, Cleveland and Acme; central New York. Box 653, AMERICAN MACHINIST.

Toolmakers wanted; first-class men experienced on jigs, fixtures and fine gages for close

small work. State age, experience in detail, and wages expected. Remington Arms Company, Ilion, N. Y.

A New York company sending an automatic metal stamping machine to England wants to make arrangements with a mechanic to operate it in return for passage over and week's engagement there at good wages. Box 664, AMERICAN MACHINIST.

Wanted—By technical school in Greater New York, for evening work, instructors in mechanical drawing and machine design; experience and ability to direct and interest men, necessary. In answering, state age and experience. Address "M. C. M.," AM. MACH.

Lathe, planer and boring mill hands wanted for day and night shift; no labor troubles, increasing force; applicants must state wages desired, past experience, if employed at present, and the names of past employers, to receive further consideration. Application considered confidentially. Apply Ingersoll-Rand Co., Painted Post, N. Y.

Wanted—High-class factory superintendent to take charge of plant employing 750 hands; eight acres of floor space, 1800 machines; plant includes machine shop and tool room for manufacturing all tools and machinery in use; none but first-class men need apply; one with technical education preferred. Box 640, AMERICAN MACHINIST.

Wanted—First-class machinists and toolmakers; open shop, nine hours per day, six days per week; all new modern tools; no labor troubles; plenty of work on hand; clean, healthful, up-to-date city in which to live; highest wages paid to workmen who can demonstrate their ability to be rated as first-class machinists. Apply stating experience, references and wages required. Box 629, AMERICAN MACHINIST.

Wanted—A thoroughly practical and energetic mechanic to take a position as rate fixer on premium work in the shop, building high-speed engines; must be familiar with jigging work and fixtures; must have fair education, good at figures and systematic; must be able to go into machine shop and make demonstrations. Apply stating age, nationality and previous experience, also whether employed at present and by whom. Answers will be treated confidentially. Box 643, AMERICAN MACHINIST.

OHIO

Machinist. 201 Nicholas Bldg., Toledo, O.

Machinists—Lathe, boring mill and vise hands, thoroughly experienced. Address The Bullock Electric Mfg. Co., East Norwood, O.

Several first-class draftsmen with experience on crane and heavy machine work; state age, experience and salary expected. Box 590, AMERICAN MACHINIST.

Wanted—Experienced foreman for milling machine and gear-cutting department in shop manufacturing machine tools; reply, stating age, experience and wages desired. Address Box 667, AMERICAN MACHINIST.

Draftsman for high-grade machine-tool work; advanced position; large factory; applicant must be thoroughly capable in original designing; reply fully, giving experience in detail and state age and education. Box 670, AMERICAN MACHINIST.

Machinists—We are increasing our output, and invite application from machinists with experience on lathes, turret lathes, boring mills, milling machines, screw machines, etc. State full experience and wages. Foos Gas Engine Co., Springfield, Ohio.

Supervisor of labor for factory employing 500 men. Line, machine tools. Must be specially qualified to handle all matters pertaining to the employment and efficiency of labor. State age and education and give full particulars regarding experience, especially during the last five years. Box 671, AMER. MACH.

Wanted—A superintendent in a machine shop employing 100 men and manufacturing heavy pressure hydraulic machinery; he must be high-class, systematic, energetic and a thorough executive; state past experience and present position; no inquiries will be made of present employer unless authorized by applicant. Address Box 601, AMER. MACH.

PENNSYLVANIA

Machinists wanted. Lathe, boring mill and floor hands, air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—A good live agent in every shop or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Klenzola Co., Erie, Pa.

RHODE ISLAND

Foreman for bolt forging department of nut and bolt manufactory; must have had experience with Burdict headers and be familiar with the making of special bolts of all kinds; give references, age and salary expected. Box 646, AMERICAN MACHINIST.

WISCONSIN

Wanted—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 564, AMER. MACH.

FOREIGN

Wanted by European machine-tool agency: German speaking mechanic, not over 30, unmarried, familiar with American machine-tool practice, to go abroad for starting up machines and demonstrating their efficiency; also Hungarian with good education and shop experience, familiar with conditions in Hungary as traveling salesman. Box 652, AMERICAN MACHINIST.

For Sale

For Sale, second-hand, one 12x24 Harris-Corliss engine and one 30-horsepower James Leffel & Co. high-speed engine; both in prime condition, and may be seen in operation; delivery December 1. Box 645, AMER. MACH.

Patent For Sale of recent date on an automatic screw machine equipped with patented self-opening adjustable die head; especially adapted for making screws and small parts for electrical and typewriter work; machine can be seen in operation at L. & M. Wollstein, 16 John street, New York.

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The Aeroplanes at Rheims and Their Records

1300 Flights, No Accidents; 11 Machines in Air at Once; Motors Were Reliable, Stability Has Been Attained, Flights Made in High Wind

BY AUGUSTUS POST*

Another landmark has been set up in aëroplane development, the forces crystallizing aëroplane design have been strengthened, important lessons have been taught and new records set up by the recent aviation contests at Rheims, France. To Americans it is a source of gratification that the international cup was won by the only American contestant, Glenn H. Curtiss, and thereby the contests of next year are to be held on American soil.

Some of the more important features of the trials are: A total of 1300 flights and no accidents; the never before seen spectacle of eleven aëroplanes in the air at once; the passing of aëroplanes at different levels in the air, demonstrating that rules for the aërial highways are now needed; setting up of new long-distance and long-period flight records; flight in a high wind, showing that the aëroplane is not of necessity a fair-weather machine; proof that stability has been attained and reliable motors developed. No light was thrown, however, on the relative merits of monoplane and biplane, for of the four successful machines, two are monoplanes and two biplanes. The record for 10 kilometers is held by Blériot with a monoplane, for 20 and 30 kilometers by Curtiss with a biplane, for distances up to 150 kilometers by Latham with a monoplane, and for distances from 160 to 180 kilometers by Farman with a biplane. Thus the honors for the two types are even indeed.

Referring to the illustrations, Figs. 1 and 2 are of interest, as showing several machines in flight at once. The upper one in Fig. 1 is Blériot's monoplane; the two lower are Farman biplanes. In Fig. 2 the left-hand machine is the Curtiss biplane and the right-hand a Voisin machine.

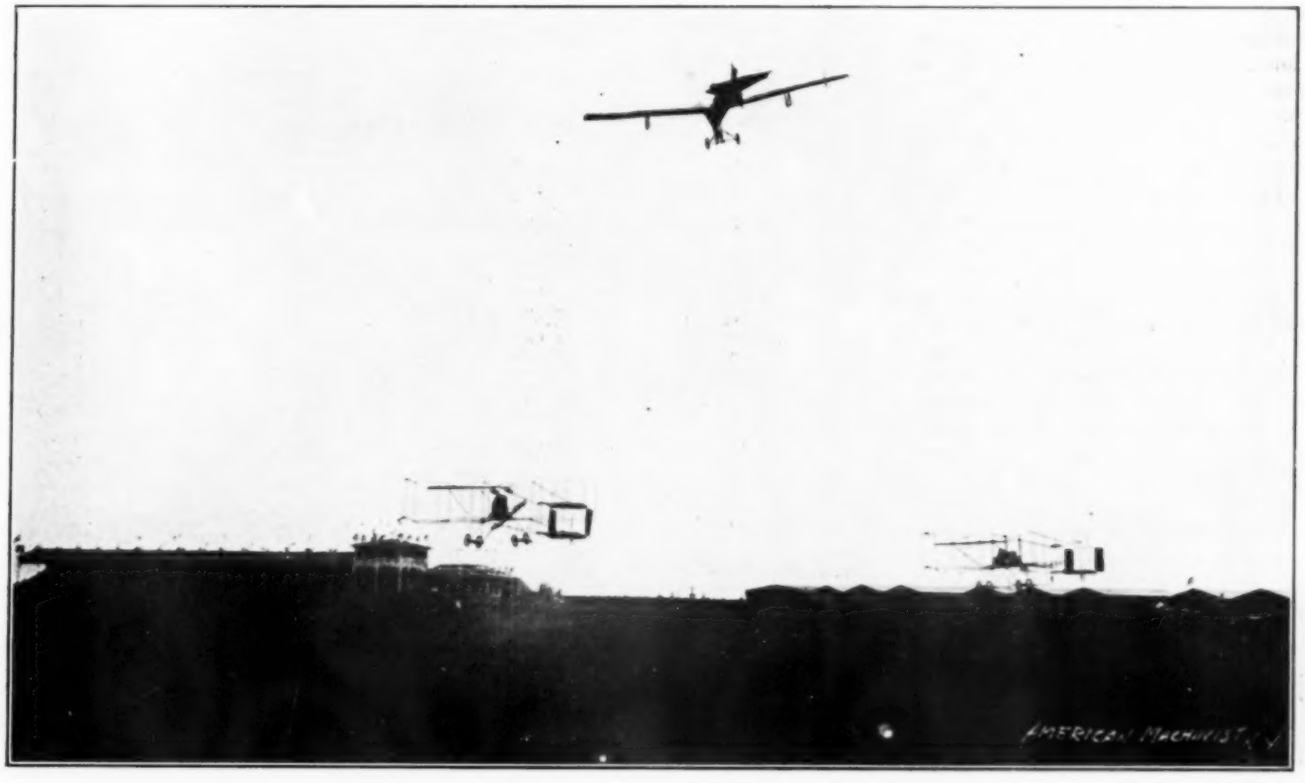


FIG. 1. AËROPLANES IN FLIGHT AT RHEIMS

Records Made at Rheims

The records for both time and distance made at Rheims are shown in Table 1, compiled by George F. Campbell Wood. They are worthy of study, both for the speeds attained, 47 miles per hour as a maximum, and the distance, over 118 miles.

Arrangement of Signals

Elaborate preparations were made to take the time and distance of the contestants and to police the grounds. Over 200,000 paid admissions were taken at the entrances and it is estimated that 100,000 persons were outside the gates. This gives an idea of the intense enthusiasm that prevails in France today in regard to aviation, and hints at what we may experience here after the American people are once aroused.

A unique method of designating the contest and the contestant making his trial, also for advising contestants at distant parts of the aviation ground, and transmitting various orders from the committee, was used. It resembled the system of signaling employed in manœuvering a squadron of battleships. A tall mast, with yard arms, see Fig. 3, was erected at the official enclosure, from which were suspended signal forms of different shapes and colors. At the top were displayed pennants which told whether flight was probable, impossible, or that flights were in progress. Below were the two-colored signals showing which contest was in progress. Each contestant was allotted a number formed by a combination of two

*Secretary Aero Club of America.

signals hoisted to the yard. Distinct geometrical forms were used in order that they might be seen in still air.

The illustration shows that the Grand Prix de la Champagne of $10,000, offered to the machine that covers the greatest distance, is being contested for by: No. 7, Comte de Lambert, in a Wright biplane; No. 5, Jean Gobron, in a Voisin biplane; No. 32, Georges Cockburn, in a Farman biplane, and No. 17, de Rue (Captain Ferber) in a Voisin biplane.

The Successful Aëroplanes

Turning to Tables 1 and 2 it will be noted that the four successful machines are Blériot's, Curtiss', Latham's and Farman's. Of these the American Machinist has illustrated and described two of Blériot's machines recently, beginning on page 383. There it was characterized as a very fast machine, a feature that is now amply demonstrated.

Curtiss' biplane is almost identical with the machine of the Aëronautical Society described in the American Machinist, beginning on page 49 of the present volume, except the power plant. Details are shown in Fig. 4 of the motor and propeller built especially for aëroplane, Curtiss No. 1, and used in the Rheims contests.

This motor is a combination of two of Mr. Curtiss' old-type four-cylinder aëroplane motors with its eight cylinders placed at an angle like the letter V. The cylinders are 4x4.5 inches, water cooled by a force pump, with forced lubrication, the oil flowing through a hollow cam shaft to the bearings and returning to a reservoir below the crank case. An auxiliary oil pump is provided to be worked by the foot to supply additional oil when necessary.

The engine develops about 60 horsepower and weighs about 200 pounds. It is provided with a 13-gallon fuel tank and carries 3 gallons of lubricating oil.

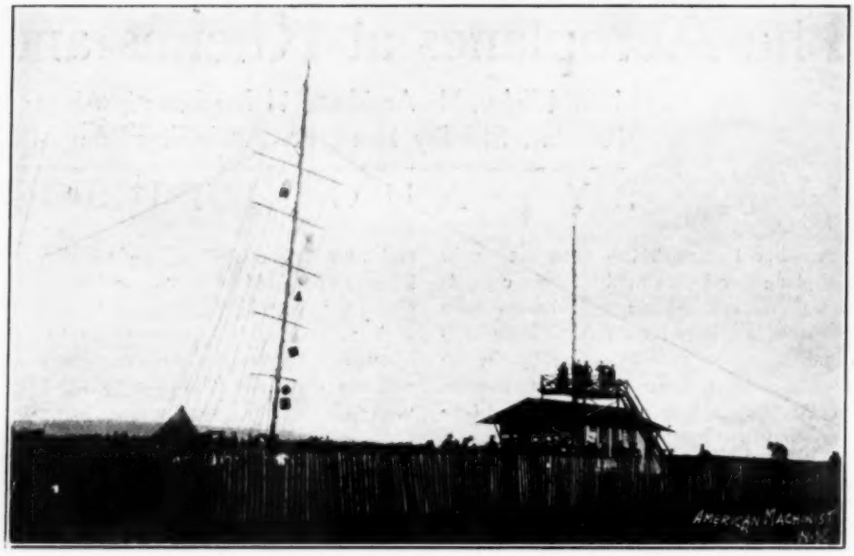


FIG. 3. THE SIGNALING MOST USED AT RHEIMS

Kilometers	Miles.	Time. H.	M.	S.	Aviator.	Date.	Aëroplane and Motor.		
10	6.214		7	47⅕	Blériot	August 28, 1909	Blériot XII monoplane. E. N. V.		
20	12.428		15	37⅖	Curtiss	August 29, 1909	H. Curtiss biplane Curtiss.		
30	18.641		23	29	Curtiss	August 29, 1909	H. Curtiss biplane. Curtiss.		
40	24.855		33	40	Latham	August 26, 1909	Antoinette VII monoplane. Antoinette.	8th to 11th lap	Of his afternoon attempt for the distance prize—(Prix de la Champagne).
50	31.069		42	27	Latham	August 26, 1909		8th to 12th lap	
60	37.282		51	23	Latham	August 26, 1909		8th to 13th lap	
70	43.496	1	00	04	Latham	August 26, 1909		8th to 14th lap	
80	49.710	1	09	05	Latham	August 26, 1909		4th to 11th lap	
90	55.924	1	17	52	Latham	August 26, 1909		4th to 12th lap	
100	62.138	1	26	41⅕	Latham	August 26, 1909		3d to 12th lap	
110	68.352	1	35	29	Latham	August 26, 1909		4th to 14th lap	
120	74.566	1	44	18⅖	Latham	August 26, 1909		3d to 14th lap	
130	80.780	1	53	47⅗	Latham	August 26, 1909		2d to 14th lap	
140	86.994	2	03	10	Latham	August 26, 1909		first 14 laps	
150	93.207	2	13	09	Latham	August 26, 1909			
160	99.421	2	43	35⅗	Farman	August 27, 1909	Farman biplane. Gnome		
170	105.635	2	54	04⅗	Farman	August 27, 1909			
180	111.848	3	04	56⅕	Farman	August 27, 1909			
190	118.062 (unofficial)	3	15	..	Farman	August 27 1909			

TABLE 1. AEROPLANE RECORDS FOR DISTANCE MADE AT RHEIMS, AUGUST 26 TO 29, 1909, OVER A RECTANGULAR COURSE OF 10 KILOMETERS (6.21 MILES) PER LAP.

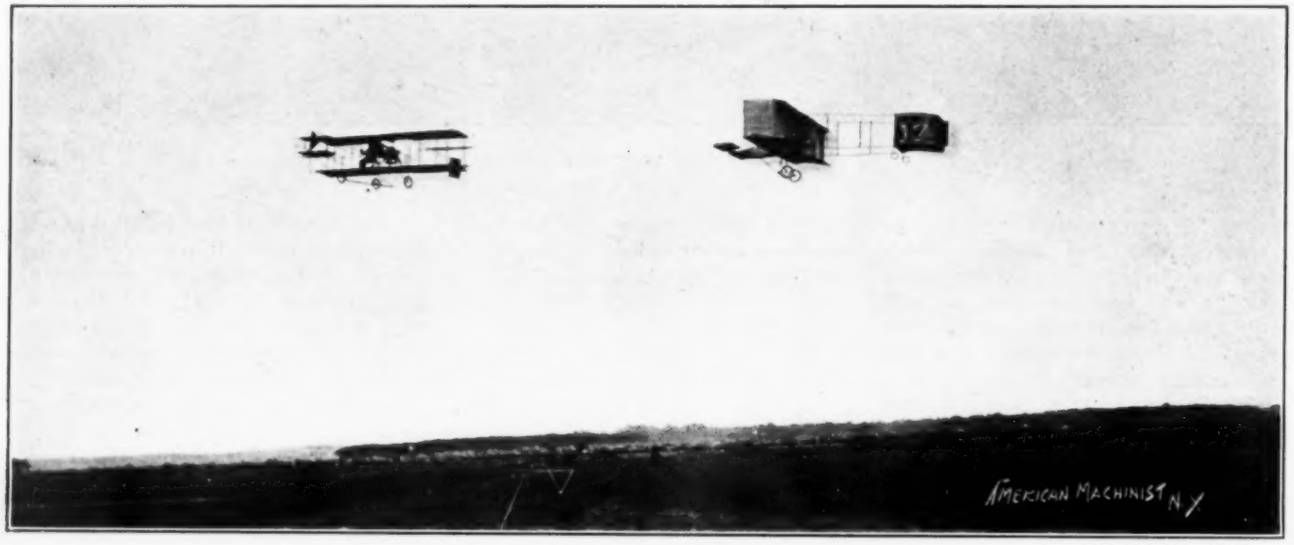


FIG. 2. AËROPLANES IN FLIGHT AT RHEIMS

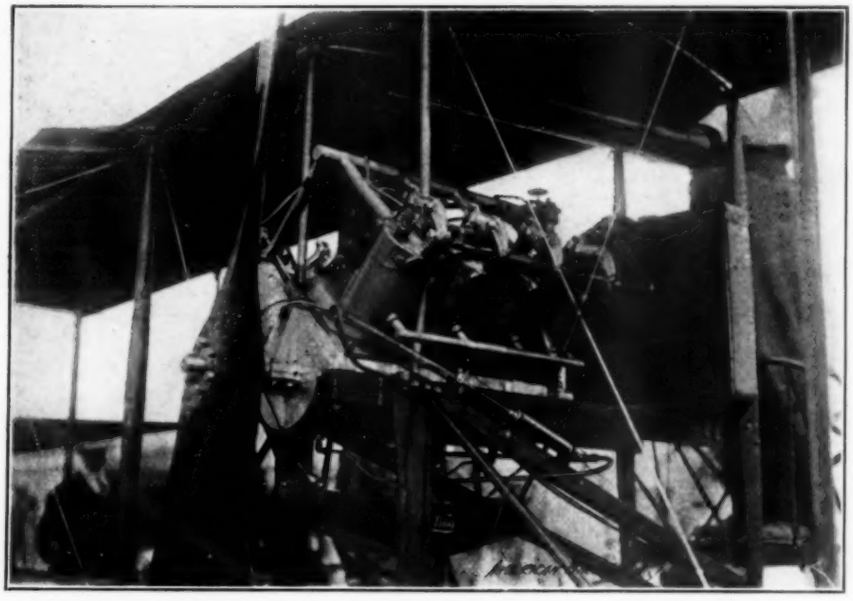


FIG. 4. THE ENGINE OF THE CURTISS MACHINE AT RHEIMS

Date.	Time.	Aviator.	Average Speed per Hour. In Kilometers.	Miles and Yards.
August 28, 1909	Greatest speed	Blériot	76.956	47 1442
August 29, 1909	¼ hour	Curtiss	76.775	47 1244
August 26, 1909	½ hour	Latham (8th to 11th lap)	71.287	44 522
August 26, 1909	1 hour	(8th to 14th lap)	69.922	43 789
August 26, 1909	2 hours	(first 14 laps)	68.200	42 666
August 27, 1909	3 hours	Farman	58.542	36 667

TABLE 2. AEROPLANE RECORDS FOR TIME MADE AT RHEIMS, AUGUST 26 TO 29, 1909, OVER A RECTANGULAR COURSE OF 10 KILOMETERS (6.21 MILES) PER LAP.

The propeller develops a thrust of 280 pounds and is built up of wood, laminated. The whole machine loaded weighs in the neighborhood of 700 pounds.

A slight change has been made in the curvature of the planes to give increased speed in the air and 15 inches has been taken off from each side of the main planes, leaving the total area about 225 square feet. The balancing planes at the side have also been made to conform to a curve where before they were simple flat planes.

The Latham machine is of the monoplane type and presents many interesting features of design which a lack of space prevents me from illustrating and discussing here.

The Farman Biplanes

However, I will present the Farman machine in some detail as it presents an interesting and valuable development in design.

Mr. Farman bought the second biplane that the Voisin Brothers made, see Fig. 5, and in September, 1907, he made short flights of 30, 40, 50, 100 and 120 meters, and in October he flew 770 meters in a straight line. On January 13, 1908, he won the Grand Prix d'Aviation, a prize of 50,000 francs, offered by Messrs. Deutsch and Archdeacon for the first flight of a kilometer made in a complete circle. This historic flight was made at Issy-les-Moulineaux, near Paris. At the same place, on July 6, 1908, Mr. Farman won the Armengaud prize of 20,000 francs which was offered for the first flight of over 15 minutes' duration. He remained in the air for 20 minutes and 20 seconds and covered 12 miles. He made the first cross-country flight from Chalons to Rheims in 1908, starting from the military grounds at Chalons and landing in the city of Rheims, a distance of 20 miles. He then stated that there was a difference in the wind after passing over a village or near a forest, a fact that other aviators have noted.

Farman's First Machine

As showing the rapid progress which has been made during the last 12 months, it is most interesting to compare the machine which Farman used at Rheims with that which he brought over to this country a year ago. This machine, as built by the Voisin Brothers, was of cellular construction and consisted of two surfaces superposed with vertical surfaces on each side of the pilot. The advantages of this construction were demonstrated by Hargrave in 1855 and have been since incorporated in the famous Hargrave or box kite. There was the usual front control, consisting of a horizontal plane for

FIG. 5. THE FIRST FARMAN MACHINE, BUILT BY VOISIN

FIG. 6. THE SECOND FARMAN MACHINE

steering in the vertical plane and a vertical rudder within the box-shaped tail in the rear of the machine. Wheels were fitted under the main planes for starting and landing and were arranged with springs to take up the shock of landing. The tail was also provided with small wheels to keep it from touching the ground. The total surface was 52 square meters (560 square feet) and the weight ready to fly 530 kilograms (1168 pounds). The framework was made of steel tubing and wooden ribs covered with rubber cloth.

The main planes were 10 meters (32.8 feet) wide by 2 meters (6.56 feet) in depth. The surfaces were arched about 1 to 14. When the machine was in full flight the angle of inclination of the chord of the arch varied between 12 to 6½ degrees, according to the speed, which ranged from 14 meters (45.9 feet) to 17 meters (55.8 feet) per second.

The surfaces were 1.5 meters (4.92 feet) apart, and they were set to form a slight dihedral angle of about 140 degrees.

The pilot's seat was in the center of the machine in front of the engine, which was an eight-cylinder Antoinette, of 50 horsepower, weighing 80 kilograms (176 pounds). This motor was arranged to allow the cooling water to boil away, which limited the time that it could run.

The propeller had a steel frame covered with aluminum sheeting 2.3 meters (7.54 feet) in diameter, 1.4 meters (4.6 feet) pitch. It was mounted directly on the motor shaft and made 1050 revolutions per minute.

Steering was accomplished by means of a wheel in front of the pilot which could be turned to steer to the right or left in a horizontal plane, and pushed out or pulled back to steer down or up respectively. The wheel was connected to the vertical rudder in the rear by wires, and the extension of the shaft to which it is fixed was connected by a rod to the front horizontal control, which caused the machine to rise or descend according as the angle that it made with the line of direction allowed the wind to strike its upper or lower surface.

Farman's Second Machine

Later in the month of March, of this year, Mr. Farman worked out many of his own ideas, and built what is known

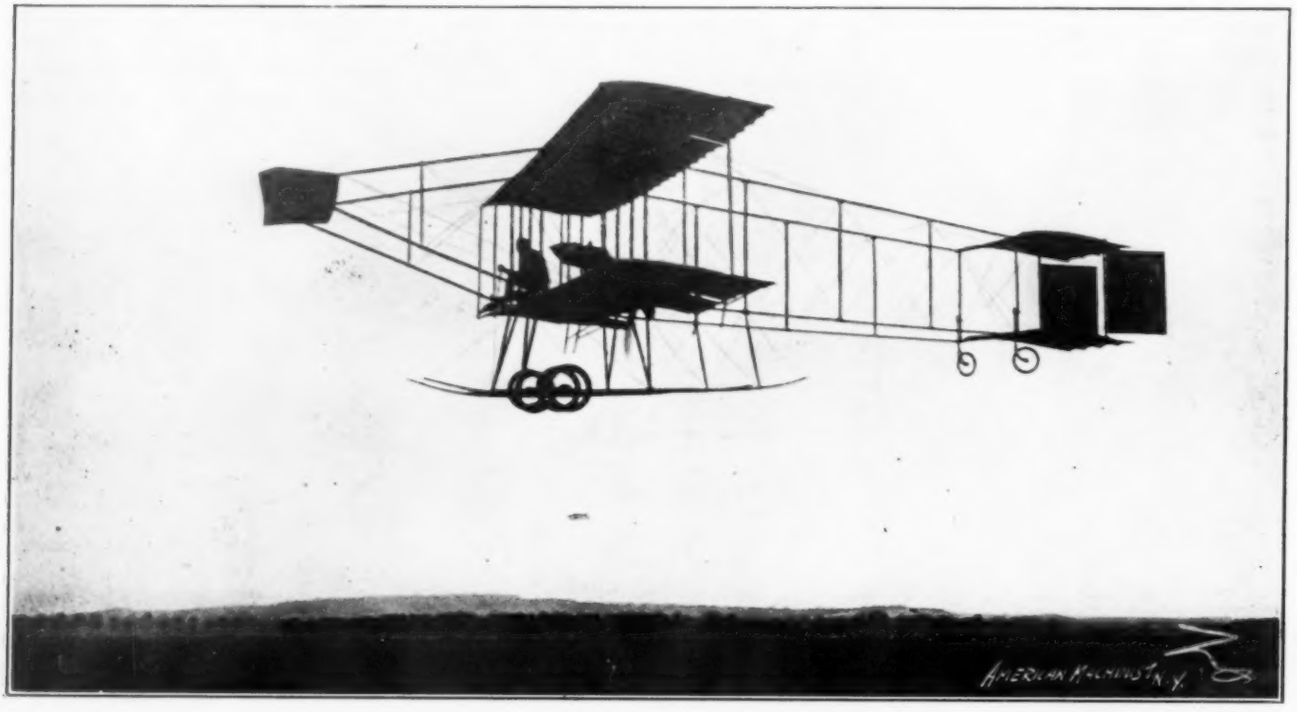


FIG. 7. THE SECOND FARMAN MACHINE IN FLIGHT AT RHEIMS

as the Farman machine. This new machine shows many material advances, see Figs. 6 and 7. The sustaining surfaces have been reduced in area. The forward horizontal rudder and the rear vertical rudder have been placed farther from the center of gravity and the rear rudder has been made double. As a result their efficiency for small variations of angle has been increased. The machine has two superposed surfaces of 10 meters (32.8 feet) in width and 2 meters (6.56 feet) in depth and the upper surface 2 meters (6.56 feet) above the lower. The planes are covered with Continental rubber cloth.

The tail is 6 meters (19.68 feet) in the rear, which gives great stability. It is of cellular construction and consists of two planes each 2 meters (6.56 feet) square. In front of the main supporting planes is a small monoplane which acts as a horizontal rudder 4 meters (13.12 feet) wide controlled by a lever. Hinged to the rear of the main surfaces and at their outer corners are the stabilizing planes, two on the upper, and two on the lower of the right and left sides, respectively. These planes can be made to take a greater angle to the wind than the main planes themselves, and are operated by a lever which actuates them all simultaneously. The steering is accomplished by two vertical rudders between the two surfaces of the cellular tail. These steering rudders are operated by means of a pivoted metal bar on which the aviator places his feet, see Fig. 8. This is connected by wires to the rudders which turn the machine to the right or left. It should be noticed that the movable surfaces hinged to the wings are not held up by wires but adjust themselves by the action of the wind. As the left hand of the aviator remains free he can move the lever controlling the admission of gas to the cylinders and make other adjustments.

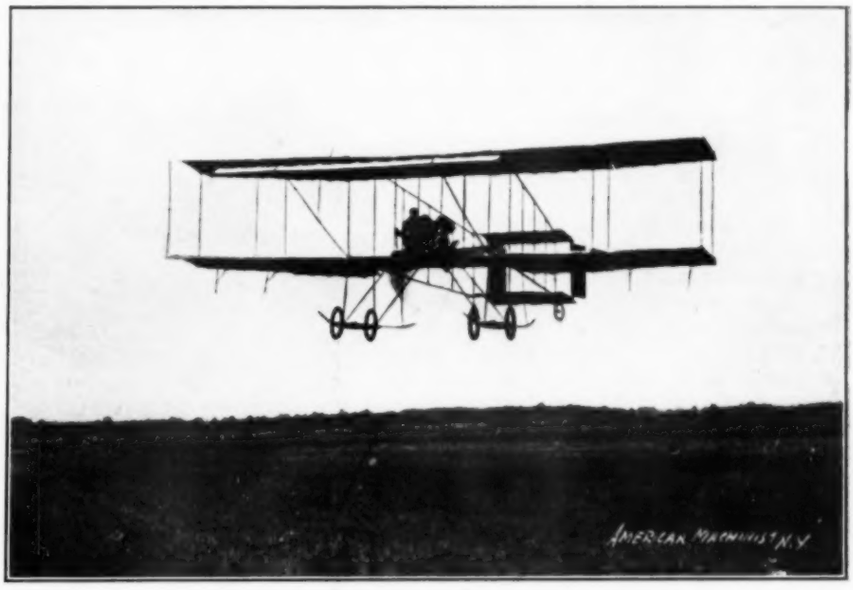


FIG. 9. FARMAN DURING HIS RECORD FLIGHT OF 118 MILES AT RHEIMS

FIG. 8. FARMAN IN HIS MACHINE WITH TWO PASSENGERS

The motor ordinarily used is a Vivinus, 35-40 horsepower, four-cylinder, water-cooled engine placed in the middle of the supporting surfaces, and coupled directly to a propeller, "Helice Integrale de Lucien Chauviere," 2 meters 60 centimeters (8.52 feet) in diameter and 1 meter 15 centimeters (3.77 feet) pitch, making 1200 revolutions per minute. The propeller is directly in the rear of the surfaces and clear of all chance of obstruction. The pilot sits in front of the motor. The apparatus is mounted on a framework under the main planes which is filled with skids having two bicycle wheels on each side of each skid attached by springs which give at the shock of landing and allow the runners to act as a brake and stop the machine quickly without accident. Under the rear tail cell are two small caster wheels which prevent it from coming in contact with the ground. The supporting surface is 40 square meters (430 square feet) and the total weight ready to fly for one hour is 550 kilograms (1210 pounds), giving a weight factor of 2.8 pounds per square foot of supporting surface.

The machine that Henry Farman used in his record-breaking flight was equipped with a Gnome seven-cylinder rotating mo-

tor weighing 75 kilograms (165 pounds), the first of its kind to be used in a flying machine.

Fig. 9 shows this machine in flight at Rheims during Mr. Farman's record distance flight of 118 miles.

Notable among the departures incorporated in the new machine by Mr. Farman are: The addition of ailerons or wing tips and the changing of the method of steering from a wheel to a pivoted lever, capable of movement in all directions. In the Voisin machine he moved the rear and front rudder by the steering wheel. In the later machine the steering in the horizontal plane is done by the feet of the aviator, while the front control and the wing tips are operated by the pivoted lever. The old machine had only two wheels; while the new machine has four wheels and skids also. By these additions Mr. Farman has sought to secure greater comfort, safety and promptitude in landing.

Special Three-Head Reaming and Tapping Machine

The machine shown in the two halftones was designed for handling cast-iron T's and L's up to 18-inch and steel T's and L's up to 12-inch. It has three heads mounted and gibbed to a T-shaped bed carrying a stationary table with T-slots in its upper surface, to which cradles are bolted for holding the work. Each head has independent hand adjustment by screw and handwheel and independent drive. Each spindle has independent feeds suitable for reaming and tapping and also rapid hand adjustment. The spindles are of high-carbon steel forgings, and have heads 11 inches diameter, with straight-hole sockets and cross-slots for driving the taps and reamers. The maximum distance from the center of the machine to the ends of the spindles, when the spindles are run back, is 26½ inches.

The spindles are driven by steel gears, and cast on these are wide projecting rims carrying on their inner surfaces four hardened-steel keys, these keys engaging crossheads keyed to the spindles, thereby transmitting the sliding motion (caused by the feeding of the spindles) to a point near to the pitch lines of the main driving gears.

Each spindle has positive feeds, driven from a sleeve gear of 1/32, 1/16 and ⅛ inch per revolution, and these are controlled by a pull pin. Each spindle has a rapid hand motion. All three feeds are used for reaming, but the ⅛-inch feed only for tapping. All feed gears are of steel or phosphor bronze.

The feeding and fast-traverse hand motion is accomplished through lead screws, which engage long nuts of phosphor bronze, which are revolved by gears carried on their circumference. The screws are located centrally with the spindles. The distance from the center of the spindles to the work table is 15 inches. Power is transmitted to each spindle through a double run of steel gears controlled by a positive clutch, which gives to the spindle speeds of from 3¼ to 14 revolutions per minute.

The tool is designed so that one man can operate two heads when machining L's and the handwheels, clutch levers, pull-pin levers and motor controllers for all operations are located conveniently for each manipulation when in one position. When T's are machined, a second man is necessary for quick work, and the operating mechanism for the third head is located accordingly. There is for each head a 12½-horsepower, variable-speed motor, or three motors in all. This machine was built at the Niles works of the Niles-Bement-Pond Company, New York City.

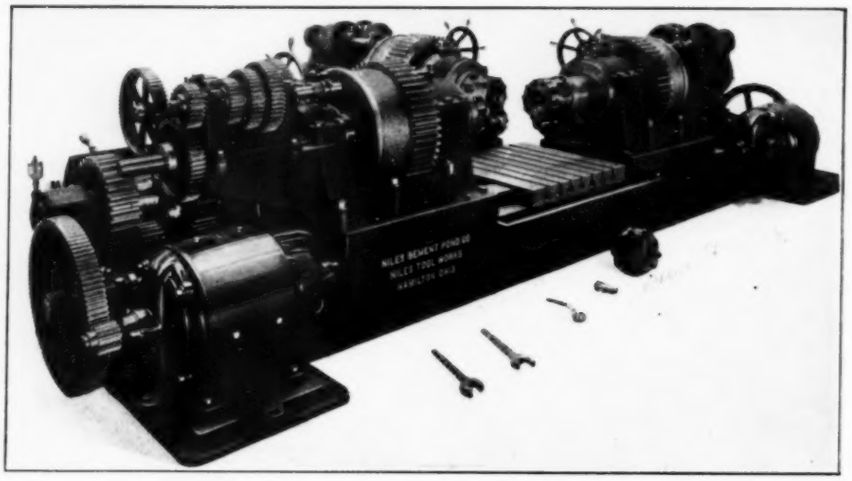


FIG. 2. THREE-HEAD REAMING AND TAPPING MACHINE

The U. S. Bureau of the Census has recently issued a bulletin, No. 102, giving some details of interest as to the fire-alarm systems of the country at the close of 1907. From the compilation it appears that for sending fire alarms and police-patrol signals, there were 1157 systems, using 70,812 miles of single wire, with 62,504 signaling stations, or boxes, giving 120,719 fire alarms. Of these 1157 systems, 48 were used interchangeably for fire alarms and police-patrol purposes, 931 for fire alarms solely, and 178 for police signaling only.

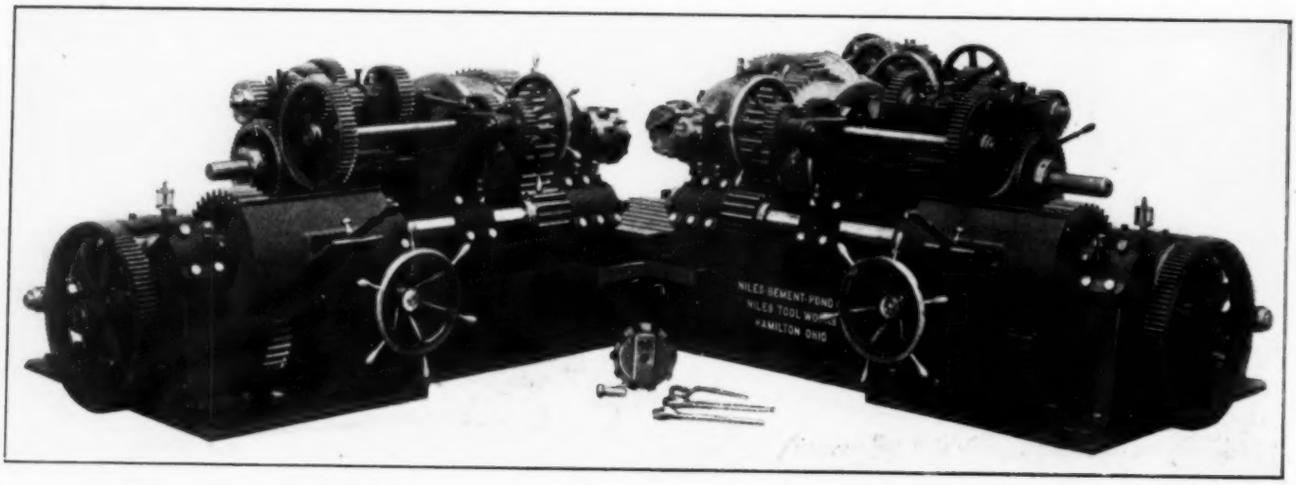


FIG. 1. THREE-HEAD REAMING AND TAPPING MACHINE

The Development of Oxy-Acetylene Welding*

By Henry Cave

As I assume that the majority of the members of this association are only interested in autogenous welding by means of the oxy-acetylene torch from the bearing it has on the future development of the use of acetylene, I will confine myself to giving such information as will enable them to form a good idea of these possibilities. I will, therefore, take up, first, the development during the past year, and then describe some of the great variety of work that has been carried out recently.

The principal development has taken place in the welding of nonferrous metals, it being now possible to weld all alloys of copper. What can be accomplished in this direction is well illustrated by Figs. 1, 2 and 3.

In Fig. 1 is shown a bronze pinion 5 inches in diameter, the tooth *A* having been cracked through on each side by the driving key and satisfactorily welded back in place.

By Fig. 2 is shown a bronze propeller, the hole in the hub being machined too large for the shaft. This was filled up solid to be machined out again.

In Fig. 3 is seen a large cast-brass water chamber, weighing 4500 pounds. This was defective and was saved by welding. The saving in a case of this kind is very large.

The development of the welding of aluminum has been considerable during the past year, cracked and broken aluminum castings being welded up with certainty; and I understand that we are away ahead of France in this work, which is rather surprising, as they had such a long start on us in experience with the torch and have been so fertile in its development.

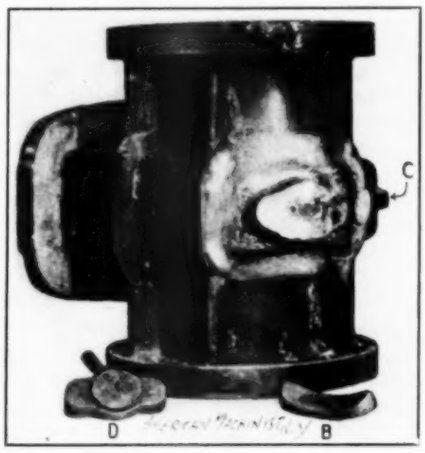


FIG. 5. PUTTING BOSS ON STEEL CASTING

The extent to which welding can be carried out in aluminum is well illustrated in Fig. 4, there being 7 feet of welding in the three aluminum cases shown. In one case the bearing was so badly broken up a new piece was cast and welded in place, the results being entirely satisfactory. Magnalium, however, gives off such a heavy oxide that satisfactory welds cannot be carried out on it.

Such alloys as monel metal, which is coming into extensive use, can be welded satisfactorily.

A better knowledge has, of course, been obtained of the action of all metals under this process. The conditions that give strong or weak welds have been clearly defined, and much knowledge has been gained as to the best methods of carrying out the work so that the results are much more certain. There are, of course, certain limitations to the practical use of this process, and these are better understood with the result that by making less failures, more confidence is given to those having only a slight knowledge of it. Possibly the greatest good that could come to the industry would be a unanimous openness between the different companies handling the apparatus as to the methods of handling work and developments in the uses for the apparatus.

The use of this form of welding in connection with mechanical means for feeding the work under the torch is being developed extensively, and in this way manufacturing can be carried out much cheaper and the results are much neater and more satisfactory than handwork. In fact, work can be accomplished with the torch under these conditions that would be quite impossible by hand.

Oxy-acetylene welding equipments are rapidly becoming a necessity in uptodate machine shops, as, even if the process cannot be used in manufacture, there are always errors in workmanship that can be corrected, and a saving thus effected. Re-

*Paper read before the annual convention of the International Acetylene Association in New York.

FIG. 1. BRONZE PINION WITH TOOTH WELDED

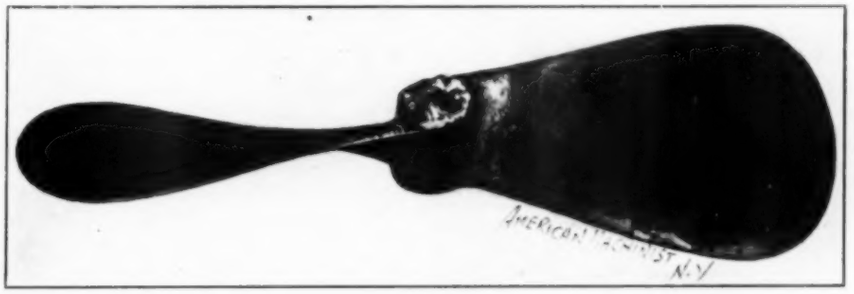


FIG. 2. BRONZE PROPELLER WITH HOLE IN HUB FILLED UP

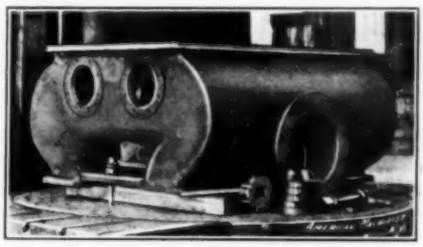


FIG. 3. DEFECTIVE WATER CHAMBER SAVED BY WELDING

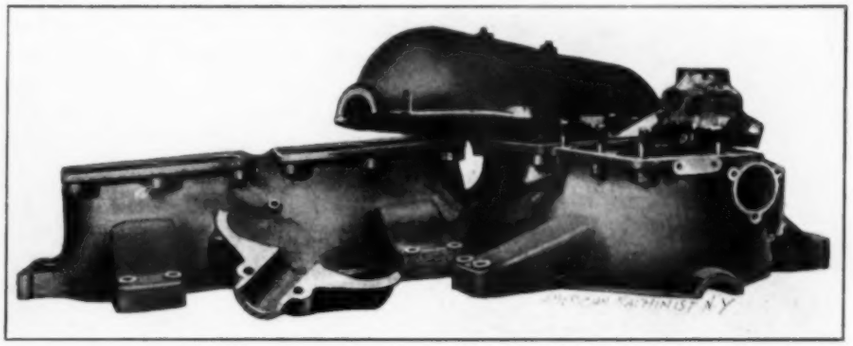


FIG. 4. ALUMINUM CASES WITH 7 FEET OF WELDING

pairs to the plant can also be carried out, often considerably reducing the length of time of a shutdown due to a breakage.

The saving that can be made by correcting errors in workmanship is well illustrated in Fig. 5, which shows a 10-inch gate-valve body made from a steel casting which, after being machined up, was found to be short of a boss, owing to the steel foundry failing to make use of the loose piece on the pattern provided for this purpose. A steel forging, shown at *B*, Fig. 5, was made so as to form as large a part of the boss as possible.

The flame of the oxy-acetylene torch is very small; the tip used for this purpose giving a welding flame that is only about ¼ inch long and ¼ inch in diameter. It is, therefore, necessary that the flame should come in contact with every drop of metal welded, it not being possible to make a lap weld. Thus it was necessary to make the forging *B* V-shaped, so that it would form a groove when placed against the wall of the casting to allow the flame to reach to the center. It was first of all necessary to cut off a lug corresponding to one shown at *C* with the cutting torch. This lug was put on the pattern for the purpose of locating the loose piece which is shown at *D*. The forging was then held in position and the torch applied, metal being added from a steel wire to fill up the groove and build up the required shape. The boss was then faced up and showed good, sound metal.

It can be readily realized from this job what a boon this equipment proves to the machine shop, as everyone knows the uncertainty of obtaining sound steel castings, and all these defects can be satisfactorily taken care of with the oxy-acetylene torch.

Another use for the equipment that is likely to develop in the near future is rail-bonding, samples of which are illustrated in Fig. 6; *E* being a ribbon bond welded on a piece of structural steel to represent

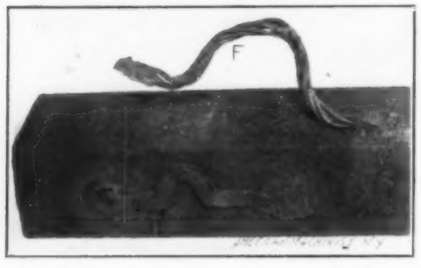


FIG. 6. BONDING RAILS

a rail, and *F* a bond made from twisted wire, one end of which has been driven off, leaving a portion of the metal, as can be seen, still adhering to the steel. It was attempted to remove this metal with a chisel, but this was found impossible without taking a chip of the steel along with it, so there is no doubt about the high conductivity and lasting qualities of the joint.

In applying these bonds it is not necessary to clean the surface as copper absorbs 4 per cent. of oxygen, and thus acts as a reducing agent. This is proven by the fact that when the surface of the steel is heated and copper melted on to it, the copper instantaneously flows over and coats the whole of the surface that is hot enough.

This process of bonding is covered by patents, and a royalty is required. But notwithstanding this, the whole bond can be applied as cheaply or cheaper than any other kind, due to the fact that scrap wire can be used for the bond instead of purchasing new material. The life of the bond, however, is infinitely longer.

It is, of course, possible to weld up the rails solid if this is desired. The best method is to weld the head and flanges, leaving open the web which is the neutral section and does not materially affect the strength as far as resistance to bending is concerned, though if desired this web can be also welded. All that is required for either bonding or welding is an equipment using dissolved acetylene. The operation would not then interfere with the continuous traffic over the rails providing it was not too frequent.

Considerable doubt has been expressed regarding the strength of welds made by this process, but though extensive tests have shown that a very large percentage of the original strength of the material can be obtained, this is of very little actual moment, as a large proportion of the welds made at the present time are in corners or other places where metal can be built up to twice the original section if desired, thus insuring ample strength under all conditions.

At the present time there are millions of dollars worth of metal parts being thrown on the scrap heap annually that could be saved by this process. You therefore see that there is ample scope for the future development of this use of acetylene.

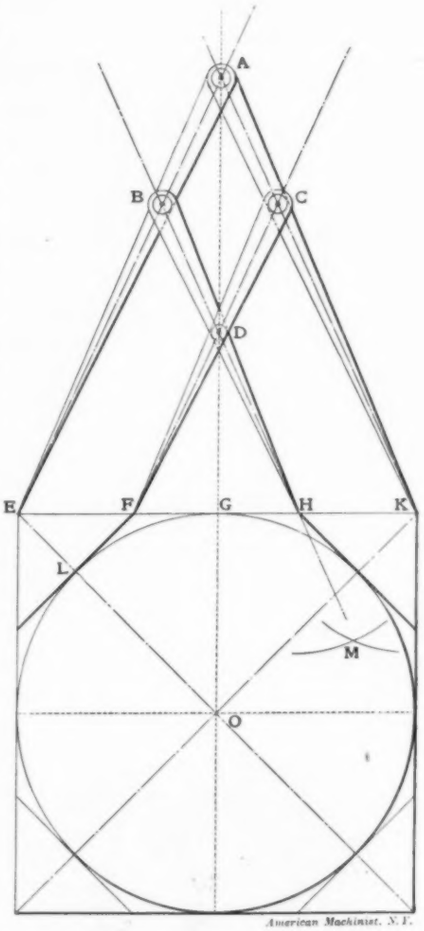
The cuts shown with this address are from photographs of work carried out by the Autogenous Welding Equipment Company, Springfield, Mass., and the Davis-Bournonville Company, New York City.

Dividers to Find the Side of an Octagon Inscribed in a Square

By G. Lisle

Sometime ago I had the privilege of going over the kit of tools belonging to David Scott, the well known builder of Shetland boats, in the employment of Messrs. Hay & Co., at Scalloway, Shetland, Scotland. Among other tools he showed me the compasses or dividers of which I submit a diagrammatic representation. It appears that the best method of securing a boat mast of approved taper and exact alinement is first of all to make a log square throughout its entire length. This block is then made octagonal in cross-section, and thereafter the octagonal edges are cut away until the block is made round. The object of the dividers is to find the sides of the octagon after the block has been squared.

The graphical construction for finding the relative lengths of the legs of the



DIAGRAMMATIC REPRESENTATION OF DIVIDERS FOR FINDING THE LENGTH OF AN OCTAGON THAT CAN BE INSCRIBED IN A SQUARE

dividers is very simple. Take a line *EK* of, say, 12 inches in length, and construct the square, circle, octagon and other lines as shown in the diagram. Then from the center *F*, one of the corners of the octagon, and with the radius the length it is desired to make the lower leg of the dividers, say, 6 inches, describe an arc cutting the center line *AO* and *D;* join *FD* and *HD* and produce them. Draw *EA* and *KA* parallel to *FD* and *HD; A, B, C* and *D* are the points for the joints of the dividers and the distances *AB, BD, DC* and *CA* are all equal.

My friend Scott explained that he got the tool from a Norwegian but had never heard of such another and I have been unable to find any reference to such a tool.

The Derivation of Empirical Formulas

Comparatively Easy for Straight Lines, More Difficult for Curves. Essential to Start with a Suitable Equation and Not Force a Fit

BY PROF. JOHN B. PEDDLE*

In a series of articles which I contributed to the AMERICAN MACHINIST last year I discussed some of the methods used in plotting curves and charts from given equations. The present article will be devoted to the reverse process; namely, the derivation of equations to fit a given set of empirical data when these data are plotted in the form of a curve or chart.

The subject is one which is full of difficulties, and so far as I know, no systematic general method has ever been devised which will give the correct form of equation to be used. The discovery of the equation's form is to a large extent a matter of intuition which can only be acquired by long experience. Some persons seem to be peculiarly gifted in the ability to pick out the proper kind of equation for use in compensating a particular set of observations, but for the rank and file of the men engaged on experimental work this is, and probably always must be, a matter of pure guesswork, which must be verified by cut-and-try methods.

In getting an algebraic expression to show the relations between the components of a given set of data there may be two entirely distinct objects in view, one being to determine the physical law controlling the results and the other to get a mathematical expression, which may or may not have a physical basis, but which will enable us to calculate in a more or less accurate manner other results of a nature similar to those of the observations.

To attain the first result it will generally be necessary to have as a starter some sort of an hypothesis as to the physical relations of the data in question, although in a few isolated cases it has been possible to arrive at hitherto unknown laws by a fortuitous treatment of the observations. In such a case as this, questions as to the intricacy or convenience of the formula in use are considered subordinate to correctness of form.

In the second case, where we want an expression which will enable us to calculate results of the same general character as the observations, form will generally be sacrificed to convenience of handling and no pretense will be made that the derived formula conforms to any physical law. This condition is one very commonly met with in engineering practice, and will be the one with which this article is chiefly concerned.

It has been a common matter of complaint among the so-called "practical" men that the "theorists" who are responsible for the formulas are very prone to unnecessary complication, and that the formulas they offer are in many cases no more exact than others of a much simpler type. It cannot be denied that there is some justification for these charges, due, perhaps, to a popular impression that a complicated formula presupposes brainwork of a high order for its production.

That this is not necessarily true needs no special proof, but, on the other hand, we should be carefully on our guard lest we be led by a desire for simplicity into devising mere rules of thumb, applicable, perhaps, to the very special conditions in which they originated, but nowhere else. As an example of this, take the numerous formulas which have been proposed in the past for the strength of gear teeth; formulas giving results which in some instances differ from each other by several hundred per cent.

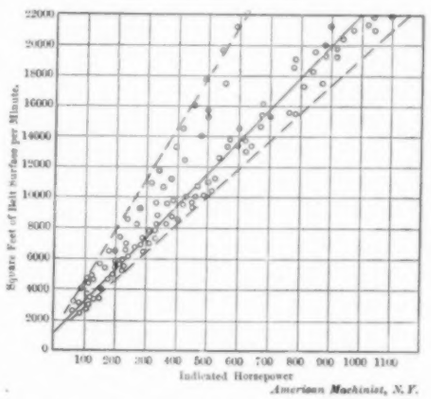


FIG. 1. CHART SHOWING RELATION BETWEEN MOVING BELT SURFACE AND HORSEPOWER OF CORLISS ENGINES. EQUATION OF MIDDLE LINE IS $y = 21x + 1000$

A few words of caution may be necessary at the start to prevent the reader from expecting too much of the processes described. Except in some of the simplest cases where the line connecting the plotted data is straight, it will generally be possible to fit a number of very different forms of equation to the same curve, none of them exactly, but all agreeing with the original about equally well. Interpolation on any of these curves will usually give results within the desired degree of accuracy. The greatest caution, however, should be observed in *exterpolation*, or the use of the equation *outside* of the limits of the observations.

If the form of the equation is known at the start to be correct and the observations are merely used to determine the constants, exterpolation will generally be safe. If, on the contrary, the form of the equation has been guessed at, exterpolation is hazardous in the extreme, and if an attempt is made to use the formula much outside of the range of the observations on which it is based serious errors may be committed.

The whole subject is full of pitfalls against which one must constantly be on guard.

About the only process for getting empirical equations which is discussed in the text books is that known as the method of least squares. It will yield satisfactory results where a good equation has been chosen at the start, but it is tedious and laborious in the extreme even under the most favorable circumstances, while for certain forms of equation the difficulties of the method are so great that it can hardly be considered as practicable. On this account, and because it can be found fully described in the ordinary text books, I shall not touch upon it here, but confine myself to a number of graphical or semi-graphical methods with which I am acquainted. Some of these at least are but little known. Nevertheless there are some very decided advantages in their use, as I hope to show later.

FINDING THE EQUATION FOR A STRAIGHT LINE

To begin with, let us take a very simple case where the relation between the variables in the equation is linear; that is, where the plotted results fall upon a straight line. The literature of engineering contains numerous examples of this type, and I have chosen as illustrations two charts taken from Bulletin No. 252 of the University of Wisconsin, entitled, "Current Practice in Steam Engine Design," by O. N. Trooien. Fig. 36 of this bulletin is reproduced in Fig. 1, and is intended to show the relation between the indicated horsepower and square feet of belt surface per minute for Corliss engines.

The necessary data for plotting this diagram were obtained from a number of engine builders. The rim speed of the belt pulley as given by them was multiplied by the width of the belt and the result was used as an ordinate, while the horsepower of the engine was taken as the abscissa. A point was thus charted for each engine, as shown in Fig. 1.

In this case, as in many others which

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occur in practice, the chart looks as if a charge of bird shot had been fired at it, and it is manifestly impossible to find a line which shall even approximately pass through all of the points.

If we have any reason to suppose that a rational formula connecting the belt surface and horsepower would be of a simple linear type, all we have to do is to draw a straight line which will coincide as nearly as possible with the "axis" of the group of points and take its equation as the best representation we can get for the data. In the case of horsepower and belt surface it is generally assumed that there is a rough proportionality between them; hence a straight line is used here. The points in Fig. 1 show two fairly distinct groups of points, and judging by eye, Mr. Trooien appears to have favored the lower group in drawing his line of average values.

This proceeding is in many instances not only justifiable, but imperative, if we wish to have our line represent the best probable values. It often happens that certain observations are known to be more accurately made than others, and hence should be given greater weight in determining the final result. In the least-square method the better observations are affected by coefficients corresponding to their greater accuracy and in the graphical method the same end is attained by causing our line to pass closer to the points representing the better observations. Just what reason Mr. Trooien had for giving greater weight to one group than to the other is not stated. It may be that the builders had a better reputation, or the results may have been more in conformity with theoretical considerations.

Our average line being located (and it will generally be found advantageous to use a fine thread stretched through the points for this purpose), its equation is easily determined. The general form will, of course, be

$$y = a\,x + b,$$

where b is the hight of the intercept on the Y-axis (in this case at 1000) and a is the tangent of the angle made by the line with the horizontal. The Y-axis, as just noted, is cut at 1000, and the ordinate, through 1000 horsepower is cut at 22,000. The difference is 21,000. Dividing this by 1000, the horizontal distance, gives 21 as the value of a.

Our formula then reads,

$$y = 21\,x + 1000,$$

or, as y represents belt speed and x the horsepower,

$$S = 21\ horsepower + 1000.$$

Where the points representing the observations scatter as badly as is the case here, the formula must be looked upon as a very rough approximation, and considerable deviation from it may be allowed in practice when for any reason this seems desirable. To indicate the limits within which this deviation may be made without departing from standard practice, Mr. Trooien draws two lines to include the extreme cases and derives the constants for them in the same manner as before. Since all the lines meet at the same point on the axis, the value for b is 1000 in each case, while a varies from a maximum of 35 to a minimum of 18.2.

The quantity laid out on the X-axis does not have to be of the first power, as in the case just discussed, and may even be itself a product of several variables. In such a case we must lay off not x itself, but x^2, x^3, $\sqrt{x}$, etc., as the case may be, or $x\,z$ if it is a product.

Another Illustration of Finding the Equation for a Straight Line

This may be illustrated by the chart for the connecting rods of Corliss engines shown in Fig. 16 of the same bulletin and reproduced here in Fig. 2.

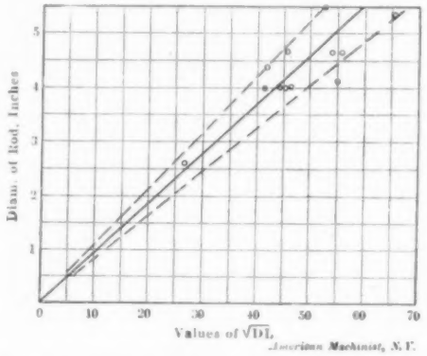


FIG. 2. CHART SHOWING RELATION BETWEEN DIAMETER OF CONNECTING ROD AND SQUARE ROOT OF PISTON DIAMETER TIMES THE LENGTH OF ROD FOR CORLISS ENGINES. EQUATION OF MIDDLE LINE IS

$$d = 0.092\sqrt{D\,L}$$

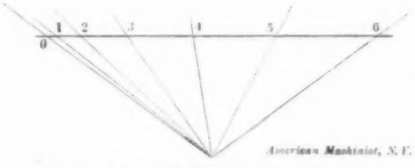


FIG. 3. TRIAL DIAGRAM OF A KNOWN FUNCTION. IN THIS CASE

$$y = x^2$$

If the Euler formula for struts be taken as correct for the connecting rod it may be reduced to the expression

$$d = C\sqrt{DL}$$

where d is the diameter of the rod, C a constant whose value is to be determined, D the diameter of the piston (supposed to be acted upon by a standard steam pressure) and L the length of the rod.

From the data furnished by the engine builders the points in the chart shown in Fig. 2 were plotted, using the values of d as ordinates and of $\sqrt{DL}$ as abscissas. The resulting line should be straight and pass through the origin, and the angle with the horizontal gives the desired value of C as 55/60, or 0.092, for the mean and 0.104 and 0.081 as the maximum and minimum values.

Finding the Equation of a Curve

Next let us consider the case where the line connecting the observations is curved. Here we have no ready-made equation as with the straight line, requiring merely the discovery of a couple of constants. The general form of the equation must be guessed at if the physical law is unknown and here we encounter one of the greatest difficulties connected with the subject and one for which it is practically impossible to offer much real help.

The appearance of the curve may or may not afford a clue and in this connection it is suggested that a book like Frost's "Curve Tracing," may be useful for reference. It contains a large number of curves plotted from various equations and their shapes will sometimes suggest a good form of equation if we are at fault.

It has sometimes been suggested as a solution of this difficulty that we plot a considerable number of functions, such $y = x^2$, $y = x^3$, $y = log.\,x$, $y = 1/x$, etc., on a straight line and then from any pole draw a series of radiating lines through the points thus found as shown in Fig. 3, where $y = x^2$ has been used. The observed results are plotted on a similar straight line for equally spaced values of the variable. This graduated line is then laid on the radiating lines and shifted around until we get the plotted points falling on them. Such an agreement would indicate at once the proper function to use and measurement of its distance from the pole would indicate the coefficient.

While this looks promising, my own experience leads me to accord it but little practical value. The observation points can almost never be made to agree even approximately with the trial function, hence I have abandoned its use.

Many experimenters assume that an equation of the parabolic form,

$$y = a + b\,x + c\,x^2 \ldots\ etc.$$

may be used for almost any class of observations with good results, and it is surprising sometimes how closely it may be made to fit unpromising conditions.

It should not, however, be blindly used for all cases, for while, on the one hand, it may be forced, with a sufficient number of terms, into the semblance of an agreement with almost any set of data, on the other hand a large number of terms is detrimental to its subsequent use in calculation and in many cases a far simpler equation may be discovered which will not only be easier to use, but may even give more accurate results. For instance, the crest of a sine curve may be made to agree quite closely with a parabola, but the longer this arc is the greater is our difficulty in getting a fit.

In fitting an equation to a given set of observations the first step is to draw through the plotted points a smooth curve. If the experimental work has been carefully and accurately done the curve may be made to pass through, or close to, almost all the points. If not, the curve must be drawn in such a way as to represent a good average, that is, so as to leave about an equal number of points at about equal distances on either side of it, these distances, of course, being kept as small as possible. Such a curve

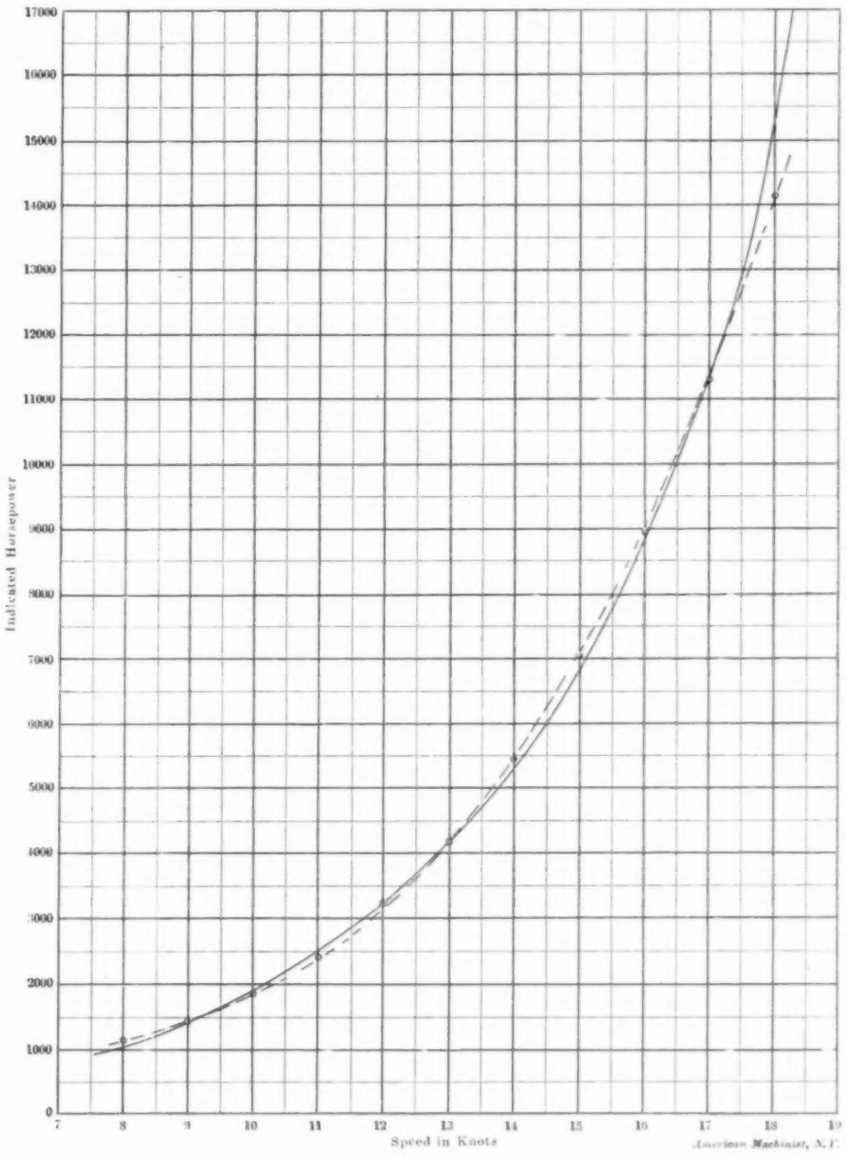


FIG. 4. CHART SHOWING RELATION BETWEEN INDICATED HORSEPOWER AND SPEED IN KNOTS FOR THE BATTLESHIP "MAINE." EQUATION OF THE CURVE IS

$$y = 440.5x - 82.32x^2 + 5.65x^3$$

is assumed to represent the most probable values of the observations and we then attempt to get its equation.

It may be stated that it is always possible to get an equation which will agree exactly with a given curve at any desired number of points, providing we use an equal number of constants in our equation.

Method of Selected Points

This is called the method of selected points and will be described first as it is the simplest and quickest method and, if a good equation has been chosen at the start, we may get results of a very satisfactory character.

For purposes of illustration I have chosen a curve given in the *Journal* of American Society of Naval Engineers for November, 1902. It shows the relation between the speed in knots and the indicated horsepower for the battleship "Maine" and is reproduced by the solid line in Fig. 4.

The data from which the curve was plotted are not given and there is no means of knowing how accurately it represents the results of the test. It will, therefore, be taken as it stands and an attempt made to find the compensating equation. As to the form of the equation, we will disregard all theoretical considerations and assume it to be parabolic since it has most of the ear marks of this type.

The curve stops at about eight knots and we have nothing to guide us as to its shape below this point. The assumption will be made, however, that the horsepower and speed become zero together; that is, that the curve passes through the origin. If this is so the first constant in the general parabolic equation (the one unattached to a variable) vanishes.

Let us assume that the equation contains the first three powers of x, or that

$$y = a\,x + b\,x^2 + c\,x^3$$

where y represents the indicated horsepower and x the speed in knots. We have here three constants whose values must be determined. To do this take three points on the curve, one at about the middle and the others at or near the ends, and form three equations, inserting in them the values of y and x for these points taken from the curve.

In the case in question I have selected the points at 9, 13 and 17 knots. The corresponding values for y (the horsepower) are 1400, 4180 and 11,350.

Inserting these in the chosen equation we have:

$$1{,}400 = 9\,a + 81\,b + 729\,c,$$
$$4{,}180 = 13\,a + 169\,b + 2{,}197\,c,$$
$$11{,}350 = 17\,a + 289\,b + 4{,}913\,c.$$

These equations are solved by the customary methods for a, b and c, giving us 440.5 for a, — 82.32 for b, and 5.628 for c.

The equation then reads:

$$y = 440.5\,x - 82.32\,x^2 + 5.628\,x^3,$$

or

$$Horsepower = 440.5\,S - 82.32\,S^2 + 5.628\,S^3.$$

The curve for this equation has been plotted on the same chart as the original curve, and is seen to pass through the chosen points exactly and to give a very satisfactory agreement at nearly every other point.

At the upper end, however, although the two curves are not much separated, there is a considerable difference in the horsepower as read from the two curves, and the indications are that this will become worse as we overstep the limits of the chart. Up to about 17½ knots, however, the equation would usually be considered as being a passable fit. The rapid rise in the horsepower as the speed increases at the upper end of the curve would indicate that better results might have been reached by the use of a higher power of x in the equation.

Another Example of Finding the Equation of a Curve

This method will answer every requirement in many cases, but too much reliance should not be placed in it without an actual test of the results. As an example of the danger of this I have applied the

method to a series of experiments showing the variation of the coefficient of friction of straw-fiber friction drives with the slip.

The experiments were made by Professor Goss who describes them in the *Transactions*, American Society of Mechanical Engineers, for 1907, page 1099.

To avoid a confusion of notation, I have replotted the curve from the original paper in Fig. 5, with the ordinates and abscissas interchanged. The small circles represent the observations and the solid curve is Professor Goss' idea of the best representation of their average value. We will attempt to compensate this curve by a suitable equation.

At first glance the curve seems to have some of the characteristics of the parabolic type, enough at any rate to make it amenable to treatment by that form of equation. It straightens out suspiciously, however, in each direction, as it leaves the region of greatest curvature near the ordinate erected at 0.4, and this would suggest the hyperbolic rather than the parabolic type. As an experiment, however, we will run it out on the assumption of its being a parabola and will try compensating by the equation

$$y = a + b\,x + c\,x^2 + d\,x^3.$$

The four constants will make it possible to get four points of exact agreement instead of three, as in the previous example, and we should naturally expect that the general agreement would be better on account of this larger number of points.

Let these points be $y = 0.55$, $x = 0.15$; $y = 0.825$, $x = 0.3$; $y = 1.42$, $x = 0.4$; $y = 2.7$, $x = 0.45$. The four equations then become:

$$0.55 = a + 0.15\,b + 0.0225\,c + 0.003375\,d,$$
$$0.825 = a + 0.3\,b + 0.09\,c + 0.027\,d,$$
$$1.42 = a + 0.4\,b + 0.16\,c + 0.064\,d,$$
$$2.7 = a + 0.45\,b + 0.2025\,c + 0.091125\,d.$$

The solution of these equations gives us $a = -5.89$, $b = 80.5$, $c = -308$, $d = 381.8$,

or,

$$y = -5.89 + 80.5\,x - 308\,x^2 + 381.8\,x^3.$$

The values of y were now calculated for every 0.05 of x from 0.1 to 0.5, and the result is shown by the broken line on the same diagram. It hits the selected points with practical exactness, but it would require a vivid imagination to say that the fit elsewhere was even fairly good. A larger number of selected points and constants would undoubtedly have helped materially in improving this state of affairs, but the most cursory inspection of the diagram will show that the trouble is not due to the small number of points, but rather to a radical error in the choice of an equation. The two curves are not of the same family at all.

Returning now to the suggestion made above as to its hyperbolic form, let us see what can be done on that supposition. We will assume that the curve is a rectangular hyperbola of which we do not know the asymptotes.

Let us try an equation of the form

$$(y + a)\ (x + b) = c.$$

The three constants will demand three equations, and we will select for our points $y = 0.55$, $x = 0.15$; $y = 0.825$, $x = 0.3$; $y = 2.7$, $x = 0.45$.

Substituting these values in the equation above we have,

$$(0.55 + a)\ (0.15 + b) = c,$$
$$(0.825 + a)\ (0.3 + b) = c,$$
$$(2.7 + a)\ (0.45 + b) = c.$$

The solution of these equations for a, b and c, gives us

$a = -0.1806$, $b = -0.5015$, and $c = -0.1298$.

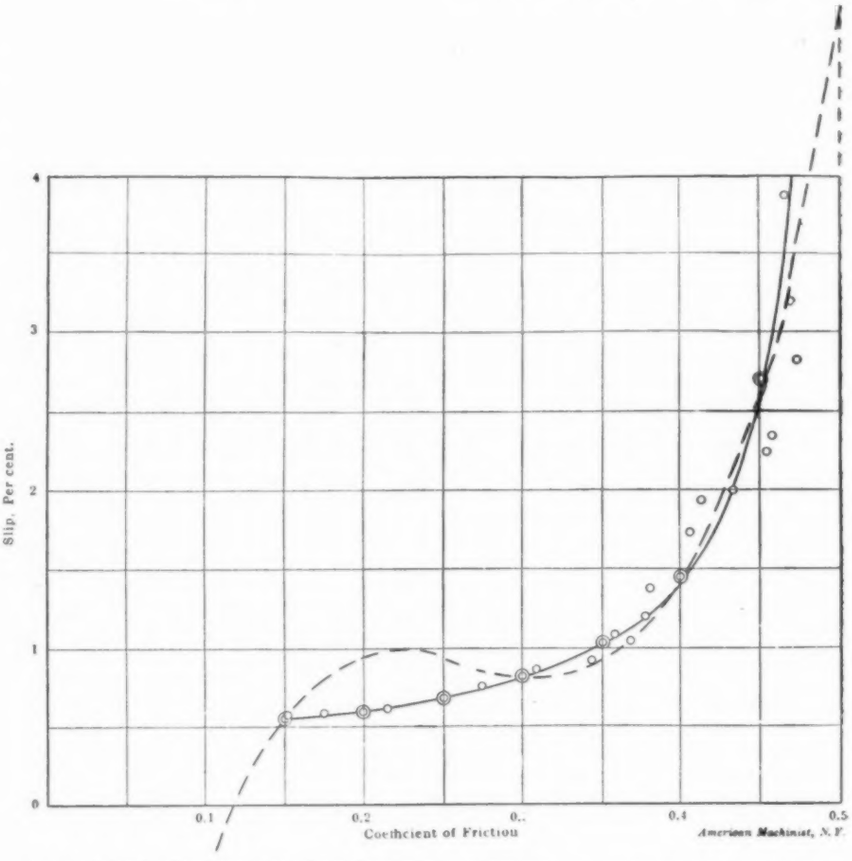


FIG. 5. CHART SHOWING RELATION BETWEEN COEFFICIENT OF FRICTION AND SLIP FOR STRAW-FIBER FRICTIONS. EQUATION IS

$$y = \frac{-0.13}{x - 0.502} + 0.181.$$

These values, in round numbers, substituted in the original equation give us

$$(y - 0.181)\ (x - 0.502) = -0.13,$$

or,

$$y = \frac{-0.13}{x - 0.502} + 0.181.$$

If, now, we substitute values of x for every 0.05 from 0.15 to 0.45, we get the points represented by the double circles in the chart. They agree so closely with the original curve as to be practically identical with it. Thus, with a less number of points we have obtained an extremely satisfactory fit, and have given a practical illustration of the statement made above as to the desirability of starting with a good equation rather than trying to force a fit by the use of an unsuitable equation and a large number of constants.

Value of Logarithmic Cross-section Paper in Determining Form and Constants of an Equation

This may be a good place to say that the logarithmic paper described in a previous article is often of great service in determining the form and constants of an equation.

If the equation involves only a simple product or quotient with no addition or subtraction, its trace on logarithmic paper will be a straight line. The tangent of the angle made by this line with the horizontal (and this may be positive or negative) will give the exponent of the variable, while the intercept on the Y-axis will give the constant by which the variable is multiplied.

It is much to be regretted that the ordinary commercial logarithmic paper is only laid off from 1 to 10 on the axes, for my experience is that almost invariably the line will extend beyond these limits, and it then becomes difficult to see clearly if it is rectilinear, since it must be broken and appear in two or more places on the sheet. If such paper were printed with graduations on each axis from 1 to 100 instead of from 1 to 10 it would greatly

facilitate many of these operations. Any curve having the aspects of the hyperbolic or parabolic type should always be so plotted since, if it does appear as a straight line, it saves a large amount of labor in determining its equation.

One special case may be mentioned here, which is sometimes useful in gas-engine work; namely, the determination of the exponent of the v in the equation for the expansion curve. If we have an indicator diagram we take the ordinates representing the pressures (absolute) and lay them out on the logarithmic paper from points on the X-axis representing the volumes (which must include the clearance). The points thus found should fall upon a line which is sensibly straight if the exponent is constant for all parts of the curve. Otherwise the exponent must be determined for any particular point by drawing the tangent to the curve there.

As an illustration, I have reproduced the expansion line from the indicator diagram of an old Clerk gas engine. The volumes are measured from the clearance line in any convenient unit. The length of the diagram made it convenient to call the clearance volume 9. From there on, the indicator diagram was divided, as shown in Fig. 6, (*a*) and the logarithms corresponding to the numbers on the X-axis were laid off on the X-axis of the lower logarithmic diagram, (*b*) of Fig. 6.

The pressures from the absolute zero were then measured from the indicator card and their logarithms laid off from the corresponding points of the X-axis of (*b*).

A straight line was now drawn to indicate the general direction of the middle set of points and then a parallel to it through 10 on the X-axis. Its intercept on the Y-axis measured in linear (not logarithmic) units gives the tangent of the angle of slope. In this case it is 1.32 which, divided by 1 (the distance to 10 measured on *X*), gives 1.32 as the value of the exponent.

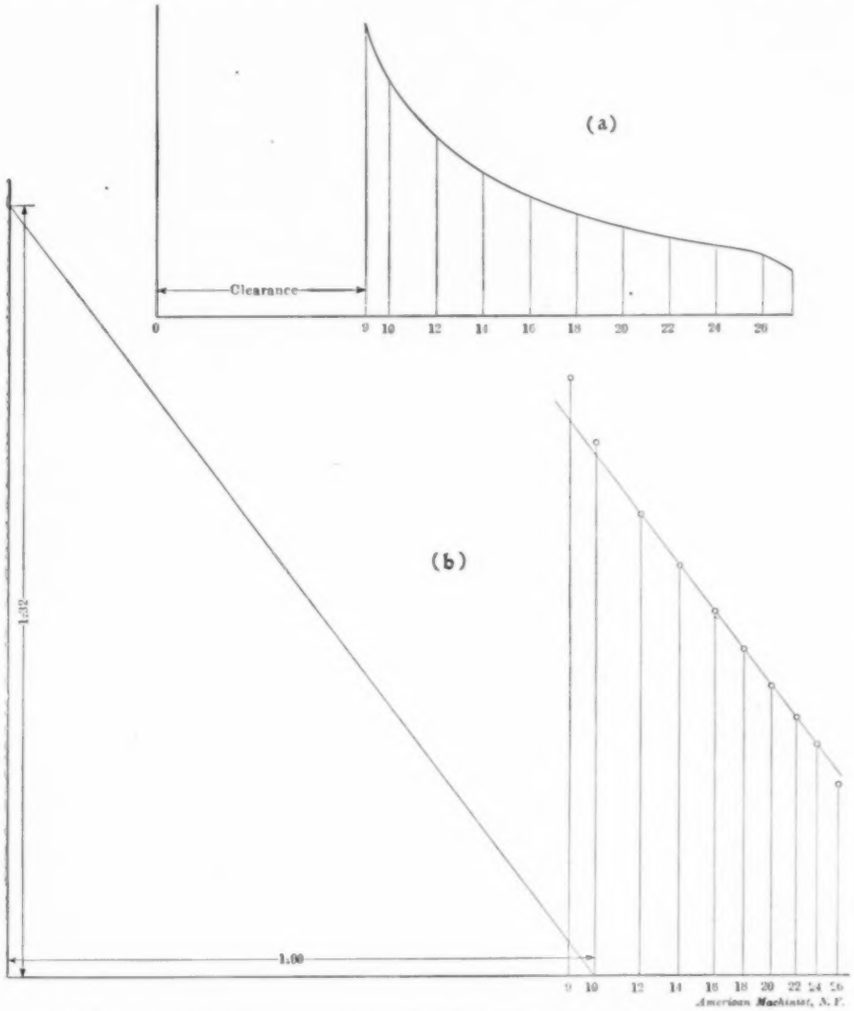


FIG. 6. EXPANSION LINE OF A GAS-ENGINE INDICATOR CARD AND LOGARITHMIC DETERMINATION OF VALUE OF EXPONENTS IN THE EQUATION OF THE EXPANSION CURVE

The method of selected points while accurate enough for many purposes, especially where the form of the equation is definitely known at the start, is not so satisfactory when we wish for greater refinement and especially when we are in the dark as to the proper form of equation. The number of points which can influence the result is no more than the number of constants employed and if we wish to use a small number of constants we cannot expect any high degree of accuracy in the fit. Some method by which a larger number of points on our curve may enter into the result without burdening the equation with constants is, therefore, much to be desired.

Method of Equating the Area and Moments Obtained from Measuring the Area under a Curve with the Integration of the Assumed Equation of the Curve

Suppose that, an observation curve being drawn, we obtain its area by any planimetric method. If, now, we find the area of the curve of the assumed equation by integration and equate it to the area just found of the observation curve, we evidently have a condition in which we can take account of as large a number of points as we please without necessarily using a large number of constants. In fact this one equation takes care of one and only one constant. It would, of course, be possible to have two curves of equal area and quite different shape if the assumed formula was not well chosen.

Suppose, however, that we get the moment of the area of the original curve by dividing it up into a number of vertical slices, taking the area of each slice above the X-axis and multiplying it by the distance of its center from any arbitrary vertical axis, generally Y, and then adding the moments thus found, we shall in this way obtain the moment about the assumed axis of the entire area between the curve and X. Its value will evidently depend upon the form as well as the area of the curve. The moment of the assumed curve may likewise be determined by integration and can be placed equal to the measured moment. This accounts for another constant. Similarly we may obtain second and third moments, etc., by multiplying the areas of the slices by the square and cube of the distances from the assumed axis and, from each of these, form equations with the same moments of the theoretical curve. We must, of course, have as many of these equations as we have constants to determine.

This is a method of considerable value which is described at some length by Prof. Karl Pearson, in the magazine *Biometrika*, for April and November of 1902. In these papers he develops the theory of the process very fully, and incidentally passes some criticism on the least-square method. The reader who wishes to pursue the subject further than is possible in this necessarily limited article is referred to the original memoir for the mathematical proofs.

Professor Pearson says that the value of the method for giving accurate results depends chiefly upon the use of a good quadrature formula for getting the area and moments of the observation curve. In these papers he, therefore, gives an

extended discussion of Simpson's and other rules for this purpose. Here again the reader who wishes this information must be referred to Professor Pearson's articles, as my only purpose is to give a rough outline of the process. It is assumed that these articles of mine will be read chiefly by men engaged in engineering where, as a rule, the conditions surrounding the experimental work are such as to make a high degree of refinement difficult. Unless the observations themselves can be connected by a smooth curve instead of falling at some distance on either side of it, as is usually the case, it would seem to be foolish to waste much time over refined methods for getting areas, etc.

For these reasons and because it will make my explanation simpler, I shall get my areas and moments in what follows by taking the mean ordinates of a series of vertical slices in the same way that we do when averaging an indicator diagram, and assume that all necessary accuracy can be secured by making the strips narrow and of considerable number. As an illustration of the application of the method it will be interesting for purposes of comparison to take again the curve for the speed and horsepower of the "Maine."

The same formula will be assumed as before, having three constants to be determined and, therefore, demanding three equations. The curve extends practically from 8 to 18 knots and these will be taken as the limits within which to work.

For convenience we will divide this space into 10 vertical slices. A greater number would lead to greater accuracy, but the work of calculation is laborious at the best and for illustrative purposes this will be amply sufficient. The hight of the curve at the middle of each of these spaces is then measured and tabulated in the column headed y alongside of the corresponding value of x. Next to the x column is one of x^2. Then follow columns for $x\,y$ (the first moment) and $x^2\,y$ (the second moment).

Since the width of the slices is 1, the hight of the middle ordinate gives us its area at once and the sum of the ordinates will be the area of the space under the entire curve.

The sum of the values in the y column gives us 53,170 as the area. The sum of the values of $x\,y$ gives us 792,785 as the first moment and the sum of the values of $x^2\,y$ gives us 12,143,327 as the second moment. Both moments are reckoned about the Y-axis.

These quantities must be equated to the area and first and second moments of the assumed theoretical curve, to get which we must use a little integral calculus. The area of a small vertical slice of hight y and width $d\,x$ is $y\,d\,x$ and since,

y	x	x^2	$x\,y$	$x^2\,y$
1,260	8.5	72.25	10,710	91,077
1,660	9.5	90.25	15,770	149,810
2,150	10.5	110.25	22,575	237,040
2,850	11.5	132.25	32,775	376,920
3,670	12.5	156.25	45,875	573,440
4,730	13.5	182.25	63,855	862,040
6,050	14.5	210.25	87,725	1,272,000
7,750	15.5	240.25	120,130	1,862,000
10,000	16.5	272.25	165,000	2,722,500
13,050	17.5	306.25	228,370	3,996,500
53,170 = Area			792,785 = M_1	12,143,327 = M_2

$$y = a\,x + b\,x^2 + c\,x^3,$$
$$y\,d\,x = a\,x\,d\,x + b\,x^2\,d\,x + c\,x^3\,d\,x.$$

The integral of this expression is the area of the curve, or

$$A = \int_{x_1}^{x_2} a\,x\,d\,x + b\,x^2\,d\,x + c\,x^3\,d\,x,$$

where x_1 and x_2 are the limits between which the integration is to be performed (here 8 and 18), or

$$A = \frac{a}{2}(x_2^2 - x_1^2) + \frac{b}{3}(x_2^3 - x_1^3) + \frac{c}{4}(x_2^4 - x_1^4).$$

This, after substituting the values of x_1 and x_2 given above, is placed equal to 53,170.

If we multiply the differential area $y\,d\,x$ by x we get its moment about the Y-axis and its integral will be the moment of the entire curve, or

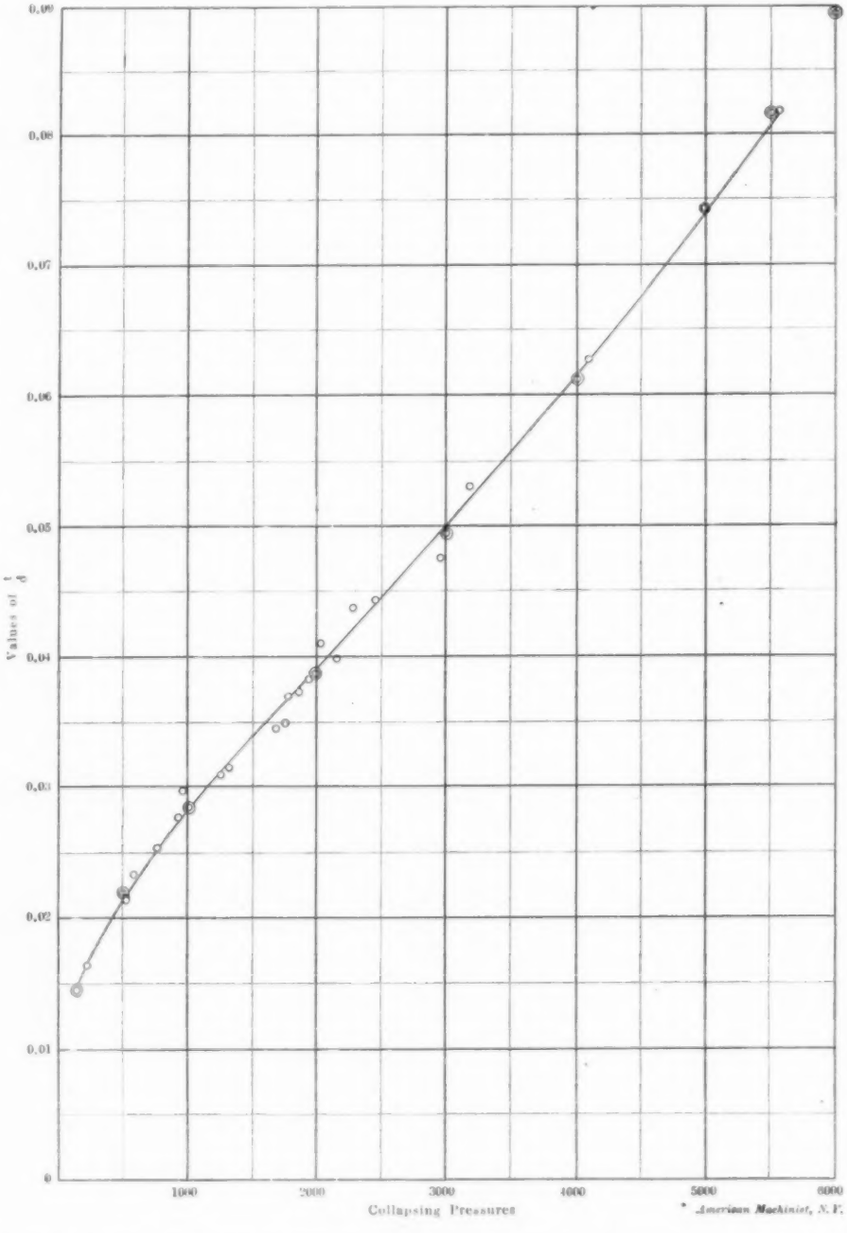


FIG. 7. CHART SHOWING RELATIONS BETWEEN COLLAPSING PRESSURE OF BESSEMER-STEEL TUBES AND THE RATIO OF THICKNESS TO DIAMETER. EQUATION OF CURVE IS

$$\frac{t}{d} = 0.00274\sqrt{P} + 0.0000000011\,P^2$$

$$M_1 = \int_{x_1}^{x_2} a\,x^2\,dx + b\,x^3\,dx + c\,x^4\,dx$$

$$= \frac{a}{3}(x_2^3 - x_1^3) + \frac{b}{4}(x_2^4 - x_1^4) + \frac{c}{5}(x_2^5 - x_1^5).$$

This is placed equal to the measured first moment or 792,785.

Multiplying the differential area next by x^2, we get its second moment about the Y-axis and its integral will be the second moment of the whole area, or

$$M_2 = \int_{x_1}^{x_2} a\,x^2\,dx + b\,x^4\,dx + c\,x^5\,dx$$

$$= \frac{a}{4}(x_2^4 - x_1^4) + \frac{b}{5}(x_2^5 - x_1^5) + \frac{c}{6}(x_2^6 - x_1^6),$$

which must be placed equal to 12,143,327.

After substituting the limiting values of x_1 and x_2, which are 8 and 18, we have the three equations

$$130\,a + 1773\,b + 25{,}218\,c = 53{,}170,$$
$$1773\,a + 25{,}218\,b + 371{,}366\,c = 792{,}785,$$
$$25{,}218\,a + 371{,}366\,b + 5{,}624{,}977\,c = 12{,}143{,}327.$$

In solving these equations, while it may not be necessary to run all calculations out to the last figures, it will generally be desirable to carry them out to five or six significant figures, since we often have to take the difference between two numbers of nearly equal magnitude, in which case the last figures may have an important influence on the result. The slide rule is, therefore, absolutely useless for these calculations except as a check against large errors. After the calculations are complete it will generally be safe to throw away all except the first three or four significant figures in order to simplify the formula for practical use.

The solution of the above equations gives

$$a = 422.8,\ b = -77.98,\ c = 5.4115,$$

making the equation read

$$y = 422.8\,x - 77.98\,x^2 + 5.4115\,x^3,$$

or, more simply,

$$y = 423\,x - 78\,x^2 + 5.41\,x^3.$$

By the method of selected points we got

$$y = 481\,x - 88.5\,x^2 + 5.853\,x^3.$$

The agreement is as close as could be expected and is really closer than the appearance of the equation might lead us to suppose.

This is shown in Fig. 4, where the equation just obtained is plotted with the previous one by selected points. As the curves run pretty close together I have not attempted to draw the last one, but have simply indicated the value of y for each even knot by a small circle.

The difference between the two curves is quite small, the last one being possibly slightly nearer the curve we are trying to compensate than the first. So small a difference would hardly make it worth while, as a rule, to use the more laborious method of moments if we knew that the results were going to come out this way beforehand. We have no means of knowing this, however, and there is generally an added feeling of safety in using it on account of the larger number of points which are taken account of. We should probably have obtained a closer approximation to the original curve by using a larger number of ordinates in getting our area and moments. Whether or not this would be desirable would have to be determined after an inspection of the calculated curve to see if its deviation from the original was within the desired limits of accuracy.

This method is of very general application and may be used for any equation of integrable form.

Alinement Chart Method

The next method I propose to discuss is one based on the alinement chart described in my article in the American Machinist, page 753, Part 1, 1908. To save repetition it will be assumed that the reader is familiar with the principles of this chart as developed in that article.

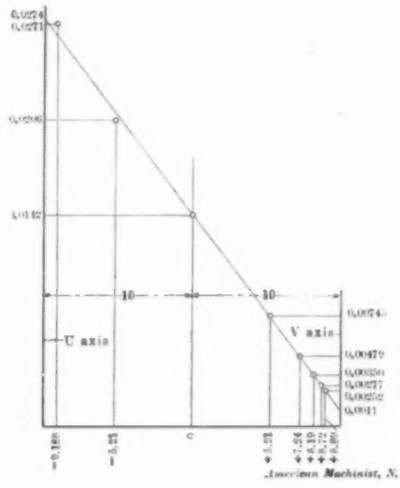


FIG. 8. ALINEMENT DIAGRAM FOR TESTING POINTS FOUND IN DETERMINING EQUATION FOR CURVE OF FIG. 7

The method is due to Captain Batailler, of the French artillery service, who describes the process in the *Revue d' Artillerie* of December, 1906. Those who are interested are referred to it if they desire fuller information than can be given in this brief outline. The process depends on the alinement of a series of points taken from the data or from a curve which is assumed to represent them.

It is not easy to explain the method in a simple manner, but I hope that I shall at least be able to make the practical application clear. This I think can be best done by working out a practical example, explaining each step as it is taken.

The example chosen will be the data given by Prof. R. T. Stewart as the results of his experiments on the collapsing pressure of bessemer-steel tubes, and published in the *Transactions* of the American Society of Mechanical Engineers for 1906. Professor Stewart showed his results in chart form by laying off the values of the thickness of the tube divided by the diameter, or t/d on the X-axis and the corresponding collapsing pressures as ordinates. He found that a smooth curve drawn through these points was difficult to represent by any simple formula and, therefore, took two bites at it, so to speak, and derived two formulas limited in their application to different parts of the field. This is a very common and useful expedient where the experimental curve is rebellious to easy representation by formula.

Let us see what can be done toward getting the whole range of results into one equation. To start with, the averages from the tabulated results have been plotted in Fig. 7, and are indicated by the small circles. In doing this I have interchanged the ordinates and abscissas as they appear in Professor Stewart's chart since, with the form of equation I wish to try there might otherwise be some confusion of nomenclature.

Then a smooth curve was passed through these points so as to represent as nearly as possible a good general average. This is not strictly necessary for the first process I am going to describe, but I have done it in order to have something definite to work toward as a measure of the success of the method, and also because a definite curve is more suggestive of the type of equation than a number of scattered points. Professor Stewart assumed that the greater part of the curve is a straight line with a sharp bend toward the origin as the lower values are approached.

He was probably justified in doing this as the small number of observations among the higher values make the direction of the curve in that region somewhat uncertain.

In my chart I have drawn the line with a reversal of curvature to permit it to pass closer to the higher-value observations and thus get a somewhat closer agreement with the actual tests. At the lower end of the curve, according to Professor Stewart the collapsing pressure seems to vary as $(t/d)^3$, or t/d is proportional to the cube root of the collapsing pressure. Acting on this hint we will use $\sqrt[3]{x}$ in our equation (x being taken to represent the collapsing pressure).

Now, the curve as I have drawn it reverses its direction of curvature as it moves away from the origin. This effect could be brought about by the use of some power of x in the equation in addition to the root. The power will have but little influence on the shape of the curve for the lower values of x where the predominant effect of the root is felt, but as we get to the higher values the power will overbalance the effect of the root and cause the reversal we wish. A high power is evidently not indicated as the bend upward is comparatively small, hence (as it is easily calculated) we will try the second.

Let our trial equation then take the form

$$y = A\sqrt[3]{x} + Bx^3$$

where y represents t/d and x the collapsing pressure.

For convenience in handling let us express these pressures in units of 1000 pounds.

The general form of equation used in my discussion of the alinement diagram was

$$au + bv = c,$$

where u and v represent measured distances on the U- and V-axes. If u and v are kept constant while a, b and c vary, we get a series of points lying along the straight line joining u and v. Hence, if this line can be determined, its intersection with the U- and V-axes should fix the values of u and v.

In our assumed formula A and B are constants, therefore let us consider that they replace the quantities u and v in the alinement equation. Now $\sqrt[3]{x}$, x^3 and y may be given various values, hence let us suppose that they take the place of a, b and c in the alinement equation.

In order to get the position of the points lying on the line joining u and v, or as we now call them, A and B, we make use of two formulas developed in the previous article. There, in order to locate our points, we used rectangular coördinates of which the Y-axis was parallel to and midway between the U- and V-axes and the X-axis was the line joining the zero points on these same axes.

The formulas for the coördinates of the various points on the third line of the diagram were then found to be

$$X = d\frac{b-a}{b+a}, \qquad Y = \frac{c}{b+a},$$

d being the half distance between the U- and V-axes.

In these equations we replace a by by $\sqrt[3]{x}$, b by x^3 and c by y.

Now, x and y are the coördinates either of the points representing the observations or of the chosen points on the curve. We will in this instance consider them as belonging to points on the curve.

Below are tabulated the quantities we shall require, x and y being read from the curve and x being given in 1000-pound units:

y	x	x^3	$\sqrt[3]{x}$
0.015	0.15	0.0225	0.531
0.0215	0.5	0.25	0.794
0.0284	1.0	1.0	1.0
0.0392	2.0	4.0	1.26
0.05	3.0	9.0	1.44
0.0616	4.0	16.0	1.59
0.074	5.0	25.0	1.71
0.0808	5.5	30.25	1.77

Substituting in the equations for X and Y we have for $x = 0.15$,

$$X = d\frac{0.0225 - 0.531}{0.0225 + 0.531} = d\frac{-0.5085}{0.5535} = -0.9188d,$$

$$Y = \frac{0.015}{0.5535} = 0.0271.$$

$x=0.5$	$X=-0.521\,d$	$Y=0.02060$
$x=1.0$	$X=0.0$	$Y=0.01420$
$x=2.0$	$X=0.521\,d$	$Y=0.00745$
$x=3.0$	$X=0.724\,d$	$Y=0.00479$
$x=4.0$	$X=0.819\,d$	$Y=0.00350$
$x=5.0$	$X=0.872\,d$	$Y=0.00277$
$x=5.5$	$X=0.889\,d$	$Y=0.00252$

These points are now plotted on the alinement chart, shown in Fig. 8. In this chart the distance between the U- and V-axes has been made 20; hence $d = 10$, and the values calculated for X will be multiplied by this before laying them off. The values of Y are laid off to any con-

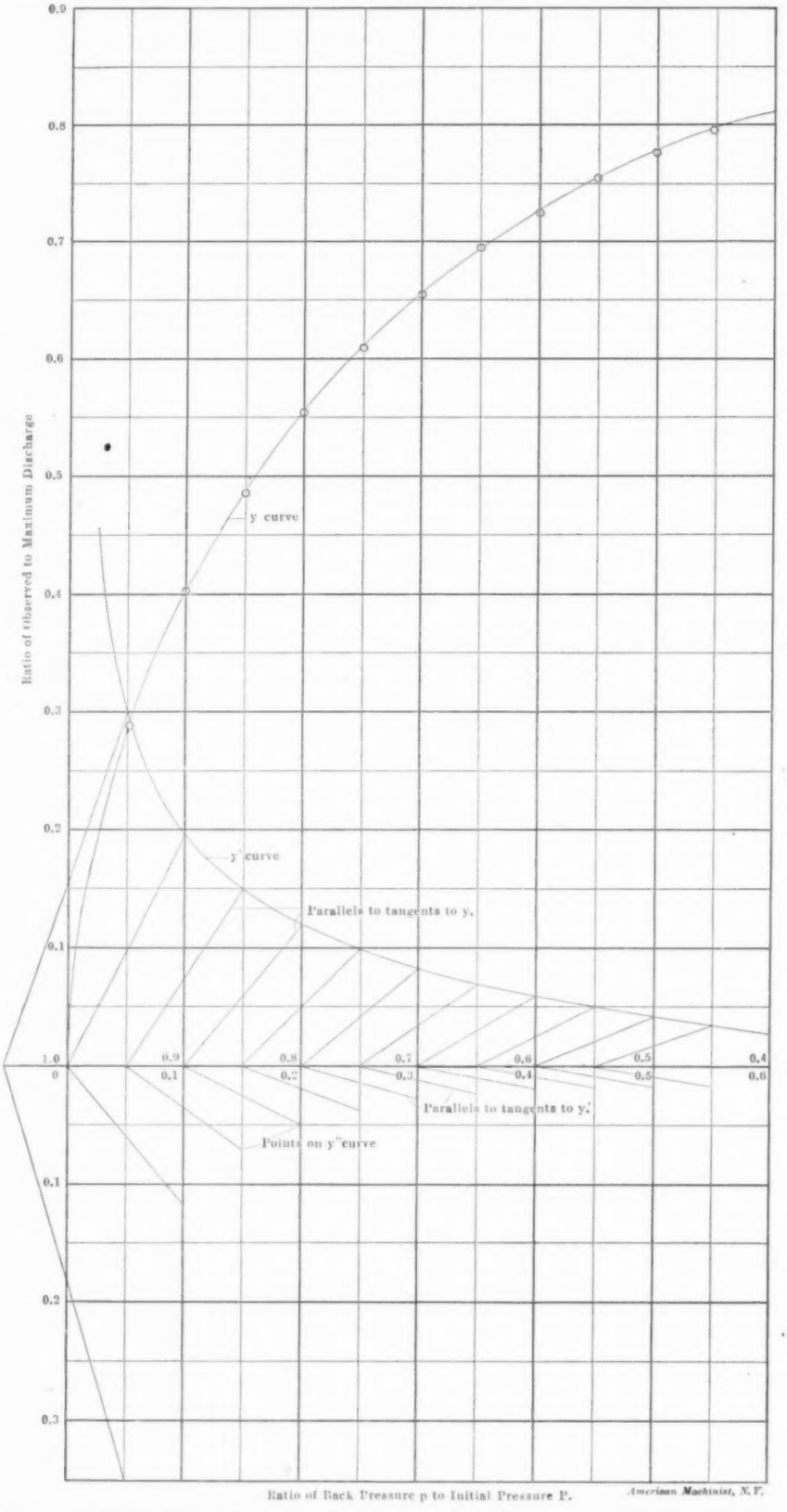

Ratio of Observed to Maximum Discharge
y curve
y' curve
Parallels to tangents to y.
Parallels to tangents to y'.
Points on y" curve
Ratio of Back Pressure p to Initial Pressure P.
American Machinist, N.Y.

FIG. 9. CHART SHOWING RELATION OF RATIO OF BACK PRESSURE TO INITIAL PRESSURE, AND RATIO OF OBSERVED TO MAXIMUM DISCHARGE OF AIR THROUGH THIN PLATE ORIFICES. EQUATION OF CURVE IS $y = -0.59x^{1.5} + 1.425x^{0.55}$

venient scale which will give clear readings. The measurements on the U- and V-axes are to this scale.

The points with the exception of the first two seem to be in nearly perfect alinement, which leads us to infer that the formula chosen is a good one. If they fail to line up in a satisfactory manner it is useless to go further, as this is an indication that the wrong equation is being used. Of course, if the ordinates taken from the observations themselves had been used instead of the points on the curve, we could not expect them to fall so nearly on a straight line, but they should be grouped close enough to one to make it evident that the axis of the group is straight and not curved.

The line extended cuts the U-axis at 0.0274, and the V-axis at 0.0011, which are, therefore, the desired values of A and B. Before using them in the equation, however, we shall have to modify them slightly to take account of the change in size of the pressure unit which is really 1000 times that which we have been working with. Thus, A will have to be divided by $\sqrt{1000}$, or 10, and B will have to be divided by 1000^2, or 1,000,000, and our final formula becomes after substituting t/d for y and P for x,

$$t/d = 0.00274 \sqrt{P} + 0.0000000011\ P^2.$$

The formula was now solved for a series of values of P, and the results are shown by the double circles on the chart. The curve could not be drawn in a satisfactory manner as it lies very close to the original for a considerable portion of its length, and this closeness is a good indication of the success of the method.

Lest I be misunderstood, let me say here that I make no pretense at having obtained a better mathematical expression for his results than Professor Stewart. The scarcity of data in the region of higher values renders it extremely unsafe to say whether the line there is straight or curved. What interested me mainly in this problem was the possibility of expressing the entire series of results by one formula. This, I believe, has been accomplished with a very fair degree of success, and by the use of a comparatively simple equation.

The method we have been investigating is generally quite sensitive, and if the equation is not a good one for the purpose the points will depart markedly from the straight line. Thus the possibility of forcing an unsuitable equation into the appearance of an agreement with the original curve, which may be done with most of the other methods, is largely absent here. Often a portion of the points will lie along a straight line while the others depart from it. In this case it indicates that in a limited field the compensation is possible and may be good, a fact which it is sometimes desirable to ascertain.

In the example just explained, we have assumed that not only the general type of the compensating equation was known, but also the values of the exponents of x.

Some guide to the choice of the exponents is evidently much to be desired, since if we rely upon guesswork we may consume a great deal of valuable time in hunting for them, and may even then not hit upon the best values.

Another Illustration of the Alinement-chart Method

The Batailler method just described may be extended to do this for many types of equation in a manner which is comparatively simple in operation, though a little difficult to explain. The additional one or two constants which may be thus determined are not limited to exponents, but may also be coefficients.

As before, I shall make the explanation while working out a problem. The example chosen will be taken from Rateau's "Flow of Steam Through Nozzles," and is the diagram shown in Plate IV of that book for Hirn's experiments on the flow of air through thin plate orifices. I have redrawn the curve for this in Fig. 9. In it the abscissas represent the ratio of back pressure p to initial pressure P, and the ordinates the ratio of observed discharge to the maximum discharge. The abscissas on the X-axis are numbered from 1 to 0.4, but I have reversed the numbering in order to avoid confusion and will afterward insert the quantities as they appear in the original diagram. My numbers will then be 0, 0.1, 0.2, 0.3, etc., instead of 1, 0.9, 0.8, 0.7, etc.

The problem will be to see how nearly we can compensate this curve by an equation of the type

$$y = A x^p + B x^q$$

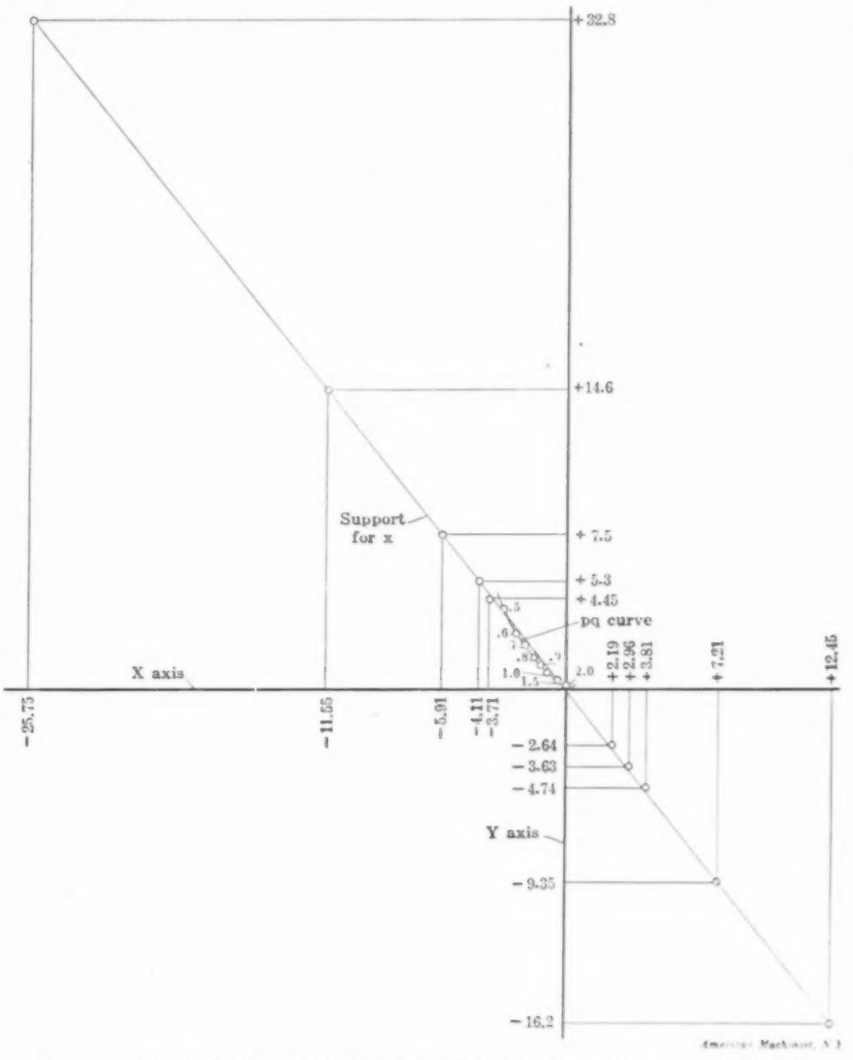


FIG. 10. ALINEMENT DIAGRAM FOR TESTING POINTS FOUND IN DETERMINING AN EQUATION FOR CURVE OF FIG. 9

in which A, B, p and q are all unknown and are to be evaluated.

The first step is to differentiate the curve and obtain its first and second derivatives y' and y''. Then A and B are eliminated from these equations, and p and q determined by a process analogous to that last described.

The equation and its first and second derivatives are:

$$y = A x^p + B x^q$$

$$y' = A p x^{p-1} + B q x^{q-1}$$

$$y'' = A p (p-1) x^{p-2} + B q (q-1) x^{q-}$$

To eliminate A and B from these equations and put them in the necessary form for use, I am reluctantly constrained to use determinants. Any other method lands us in such a snarl of equations as to be very objectionable, while by determinants we can reach the desired results by a comparatively simple process. All forms of equation will not demand this treatment, and each case must be looked upon as more or less of a special problem.

The three equations may be written in the determinant form as follows:

$$\begin{vmatrix} y & Ax^p & Bx^q \\ y' & Apx^{p-1} & Bqx^{q-1} \\ y'' & Ap(p-1)x^{p-2} & Bq(q-1)x^{q-2} \end{vmatrix} = 0$$

Divide the second column by Ax^p and the third column by Bx^q and we have:

$$\begin{vmatrix} y & 1 & 1 \\ y' & px^{-1} & qx^{-1} \\ y'' & p(p-1)x^{-2} & q(q-1)x^{-2} \end{vmatrix} = 0$$

Then multiply the second row by x and the third by x^2, giving:

$$\begin{vmatrix} y & 1 & 1 \\ xy' & p & q \\ x^2y'' & p(p-1) & q(q-1) \end{vmatrix} = 0$$

Taking the three columns as the coefficients of three equations of the alinement type, we have:

$$y = xy'u + x^2y''v$$
$$1 = pu + p(p-1)\ v$$
$$1 = qu + q(q-1)v$$

The first equation is affected only by x or its functions y, y' and y''; the second by p only, and the third by q only.

Three alinement diagrams may be constructed from these three equations on the same U- and V-axes, giving us three curves, one for x, one for p and one for q.

If we join up some point on the p-line with another on q, the connecting line will cut the x-line in what must be looked upon as a corresponding value. But according to the original assumption p and q were constants in the equation and remain so whatever the value of x. If this is true, the desired values of p and q must be so located that the line joining them will cut every value of x on the x-line. This can only be possible by having the support for x a straight line joining these constant values of p and q.

Our next step is to plot the support for x from the equation:

$$y = xy'u + x^2y''v$$

The coördinates for the points on this line will be found from the equations used in the previous example, which will read here

$$X = d\frac{x^2y'' - xy'}{x^2y'' + xy},$$

$$Y = \frac{y}{x^2y'' + xy}.$$

Here x and y are, of course, the coördinates of any points on the observation curve; y' and y'' must, however, be determined from this primary curve. As is well known, the tangent to a curve at any point corresponds to the first derivative. If we get the tangents at a sufficient number of points these values may be plotted into a second curve of which the ordinates are y'. Similarly by drawing tangents to this second curve, we get the values of the quantity y''.

These values of y' and y'' are then to be substituted in the equations for X and Y.

The chief and only difficulty connected with this process is in drawing the tangents to the curves. The "curve of error" is sometimes recommended for this purpose but is, in my opinion, too cumbersome for practical use where any considerable number of points is to be operated on.

My own preference is for taking two ordinates at equal distances on either side of the point at which the tangent is desired and draw the chord of the curve between them. If the curve is flat these side ordinates may be considerably separated, but if not they must be closer. The

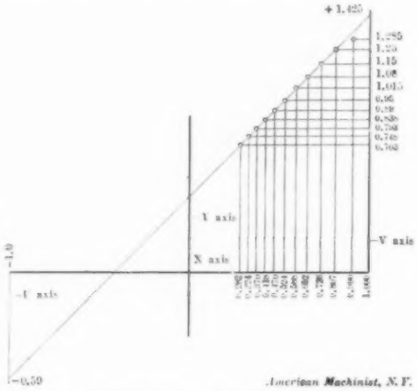


FIG. 11. ALINEMENT DIAGRAM FOR TESTING POINTS FOUND IN DETERMINING AN EQUATION FOR CURVE OF FIG. 9

slope of the chord will be nearly equal to that of the tangent. The greatest care must be exercised in this part of the process, but if this is done the method will yield results of a very satisfactory character.

To get the numerical value of the tangent, or y', a parallel to the chord is drawn from a point on the base line at unit distance to the left of the foot of the ordinate we are operating on and its intersection with the ordinate gives the desired value of y' when measured by the same scale as was used for the ordinates of the original curve.

If this unit distance is inconveniently small or large we may increase or diminish it to a more suitable value but must remember that the reading on the ordinates must then be changed to correspond.

In Fig. 9 the primary curve and its first and second derivatives are shown, the last being represented only by points and the actual curve omitted as unnecessary. It was convenient in laying out these secondary curves to use a base unit on the X-axis equal to 1/10; hence the readings on the y' curve must be multiplied by 10 to get their true value and those of the y'' curve by 100 (since we have used the 1/10 base unit twice).

In the accompanying table are given the quantities necessary for our calculations, the values of y, y' and y'' being read directly from the curves; y'', it will be noted, has the minus sign prefixed throughout, as its points all lie below the X-axis.

x	y	y'	y''	x^2	x^2y''	xy'
0.05	0.283	3.00	—34.5	0.0025	—0.0863	0.150
0.10	0.402	1.94	—11.8	0.0100	—0.1180	0.194
0.15	0.488	1.50	— 7.1	0.0225	—0.1598	0.225
0.20	0.556	1.19	— 5.0	0.0400	—0.2000	0.238
0.25	0.613	1.00	— 3.7	0.0625	—0.2313	0.250
0.30	0.658	0.83	— 2.85	0.0900	—0.2565	0.249
0.35	0.695	0.70	— 2.35	0.1225	—0.2879	0.245
0.40	0.728	0.605	— 2.0	0.1600	—0.3200	0.242
0.45	0.757	0.50	— 1.9	0.2025	—0.3848	0.225
0.50	0.780	0.42	— 1.7	0.2500	—0.4250	0.210
0.55	0.800	0.33	— 1.6	0.3025	—0.4840	0.1815

Now, substituting from the first row in the equations given above for X and Y, we have

$$X = d\frac{-0.0863 - 0.15}{-0.0863 + 0.15} = d\frac{-0.2363}{0.0637} = -3.71\,d,$$

$$Y = \frac{0.283}{0.0637} = 4.45,$$

and for the remaining values of x,

$x = 0.10$	$X = -4.11\,d$	$Y = 5.3$
$x = 0.15$	$X = -5.91\,d$	$Y = 7.5$
$x = 0.20$	$X = -11.55\,d$	$Y = 14.62$
$x = 0.25$	$X = -25.75\,d$	$Y = 32.8$
$x = 0.30$	$X = 67.5\,d$	$Y = -87.8$
$x = 0.35$	$X = 12.45\,d$	$Y = -16.2$
$x = 0.40$	$X = 7.21\,d$	$Y = -9.35$
$x = 0.45$	$X = 3.81\,d$	$Y = -4.74$
$x = 0.50$	$X = 2.96\,d$	$Y = -3.63$
$x = 0.55$	$X = 2.19\,d$	$Y = -2.64$

Slide-rule calculations are usually of sufficient accuracy for this purpose, and after a start is once made they may be run off quite rapidly.

These values must next be plotted on the alinement diagram, as shown in Fig. 10. Since we make no use of the U- and V-axes here, we will omit them and indicate only the X- and Y-axes from which the above quantities are laid off. The half distance d between the U- and V-axes appears in the equation for X, but since they are not shown, its only function will be that of a scale unit, which we may make any size we please. Here it was made of such a size that all of the points given above could be plotted within the limits of Fig. 10, except the one corresponding to $x = 0.30$.

We do not need this point, however, as there are enough other points without it to determine the alinement.

An examination of Fig. 10 shows that, although the plotted points do not lie exactly on any straight line, they are in very close agreement with the one shown. Exact agreement is never expected, of course, and there will generally be more divergence than shown here. The alinement of the points indicates that the type of equation chosen is good for the purpose. If it had not been the points

would have scattered badly, or would have had a curve as their locus.

Now, we must plot the curves for p and q for such values of these quantities as we suppose to lie near the line just drawn.

The p and q equations for this type of formula are identical, hence they will be represented by only one curve instead of by two, as is the case with other types where p and q are not symmetrically disposed. In order to get a value each for p and q, we must, therefore, have two intersections between the x support and the support for $p\,q$.

The alinement equation for p as given previously is

$$1 = p\,u + p\,(p-1)\,v.$$

The coördinates for the various points on the p support will then be

$$X = d\,\frac{p(p-1)-p}{p(p-1)+p} = d\,\frac{p^2-2p}{p^2} = d\left(1-\frac{2}{p}\right),$$

$$Y = \frac{1}{p(p-1)+p} = \frac{1}{p^2}.$$

These equations have been solved for p = 0.5, 0.6, 0.7, 0.8, 0.9, 1, 1.5, and 2, and the points thus found plotted in Fig. 10.

A larger scale for the drawing would have made things clearer, but it can be seen that the x-support cuts this curve at two points, one of them exactly at 1.5 and the other at a point between 0.5 and 0.6, which I have called 0.53. It would have required but a slight shift of the x-support to have made the intersections at the points 0.5 and 2. If convenience in use were an important factor these latter values could probably be employed with but little less accuracy. However, we will use the original more exact figures and call p 1.5 and q 0.53. It is immaterial at this stage which quantity is assigned to which letter.

Having found p and q, our equation now reads

$$y = A\,x^{1.5} + B\,x^{0.53}$$

and our next step is to proceed exactly as we did in the previous example to find A and B, using the equations

$$X = d\,\frac{x^{0.53}-x^{1.5}}{x^{0.53}+x^{1.5}}, \qquad Y = \frac{y}{x^{0.53}+x^{1.5}},$$

in order to locate the points on the test line.

As there is nothing novel in the process the details will be omitted and reference merely made to Fig. 11, where the points have been plotted and where they are seen with but one exception to lie almost exactly upon a straight line, again indicating the adaptability of the formula to the portion of the curve we have operated on. This line extended to the U- and V-axes is found to cut them at the points — 0.59 on U and + 1.425 on V.

Then A is — 0.59 and B, 1.425, and our equation reads

$$y = -0.59\,x^{1.5} + 1.425\,x^{0.53}.$$

Reverting now to the first diagram where, as was stated, the numbering on the X-axis was altered, we see that we can get the original numbers by putting

$$x = 1 - \frac{p}{P},$$

p/P being the ratio of the back to the initial pressure and the final equation may then be written

$$y = -0.59\,(1 - p/P)^{1.5} + 1.425\,(1 - p/P)^{0.53}.$$

A series of points has been calculated from this formula and plotted on the chart in Fig. 9, as indicated by the small circles and the agreement will be seen to be quite good.

The lengthy description which I have given of the Batailler method has, I know, a somewhat formidable sound, but in practical operation it is, as Bill Nye observed of Wagner's music, "much better than it sounds."

The only operation which presents much difficulty is the graphical differentiation which must be done with great care, or the results will be poor. Otherwise the work is all of a simple character, and may be carried out very expeditiously as compared with some of the other processes. While other types of equation are developed on the same general lines as the one explained, there are differences of detail which have to be looked out for, and which could not be even touched upon here without lengthening this article beyond reasonable limits. The equation we have worked on is, perhaps, the one most commonly met with in practice and shows as well as any other the very decided advantage of this process for certain classes of work.

The efforts that the manufacturers of powder, dynamite and other heavy explosives are making, in connection with the bureau for the safe transportation of explosives of the American Railway Association, are commendable to say the least, and the results of their endeavors cannot help but be a large factor in the reduction of accidents, with the consequent loss of life and property, attending the utilization, storage and shipment of explosive material. Five hundred million pounds of explosives are manufactured annually by the 150 factories in that line of industry in this country, and in the handling of this immense amount of highly dangerous product many appalling accidents occur. As the result of extended study on the part of the above-mentioned bureau, rules and regulations for the safe handling of powder and dynamite, as well as compressed gases and the more active acids and corrosive substances have been formulated, and these regulations in conjunction with the increased attention being given the matter by the government officials connected with the ordnance service is bound to show substantial beneficial results.

Reports and Discussion on Case Hardening at the Railroad Blacksmiths' Convention

At the annual convention of the International Railroad Master Blacksmiths' Association that was held in Niagara Falls in August, many interesting papers were read on such subjects as case-hardening, heat treatment of high-speed steels, flue welding, frame welding, the piecework system and numerous other subjects.

On the subject of case-hardening, H. Pentecost said: "We do a great deal of case-hardening and therefore keep men at that work only and also have furnaces built especially.

Our furnaces are built of special firebrick, each with two chambers or retorts that are made air-tight, instead of the boxes in which work is generally packed. The fire space is between and below these two chambers. They are each 15x16 inches and 81 inches long, which is large enough to take in anything on an engine that needs case-hardening, from a guide down to the smallest pin. These furnaces are full of flues, that surround the chamber or retort where the case-hardening is done, so as to keep it at an even heat all the time.

The furnaces are kept going night and day and are kept at a uniform heat all the time. A jib crane with cable air hoist is used to lift the work out of the furnaces and quenching tanks are placed in the floor, that are large and deep enough to take in all the furnace will hold.

For fuel we use hard coke, as from our experience we get a more satisfactory heat than with either coal or oil. Our case-hardening mixture is composed of charcoal, ground bone and potash in the proportions of 200 pounds charcoal to 50 pounds of ground bone and 50 pounds of potash. This mixture is renewed every three or four days, according to the size and amount of work to be done.

At the present time we are case-hardening guides 3x8 inches and 66 inches long. By using both chambers we can put in two complete sets besides other small pieces. For these guides we keep them in the furnace 20 hours as we consider that that is none too long to make a good job. When steel guides are case-hardened they are left in the furnace from 8 to 10 hours. Likewise, it takes from 10 to 12 hours to case-harden iron links, while steel links can be case-hardened in from 6 to 8 hours, according to the size.

The material to be case-hardened is packed in the following manner by the Burnside Shops, Chicago, Ill.:

Broken charcoal is taken that is about one inch in size and a layer of this put in the bottom of the box, say 2 inches deep, and then packed down with a mallet to make it solid. One pound of common

salt is then sprinkled over the charcoal; one pound pulverized sal soda over the salt; one pound pulverized rosin over the sal soda and one pound black oxide of manganese over the rosin. The pieces to be carbonized are laid on this compound, taking care not to have them too close together, nor to the sides of the box. The broken charcoal is then filled in between the pieces and well packed and care used to see that about two inches of charcoal is between the pieces. Charcoal is covered over these to a depth of two inches, when another layer of work can be added. The top of the work is covered over with layers of the same ingredients that have been put in the bottom of the box and this finished off with about two inches of charcoal in the top of the box with a little salt sprinkled over the top of it. The cover is then put on and the box placed in the furnace for from 10 to 15 hours, according to the work, where it is kept at a bright red heat. When taken out the work is cooled in clear cold water.

The size of the box for the amount of compound designated is about 12 inches deep, 15 inches wide and 40 inches long. This box will hold one set of links, blocks, plates and pins.

J. Geo. Jordan said: "Case hardening is a process of converting wrought iron into hardened steel and still retain a fibrous iron center to keep the same from breaking.

"The practice in our shop is to use cast-iron boxes of different sizes. These are 12 by 12 inches and 24, 36 and 48 inches long.

"At present we case-harden with bone black which costs about 6 cents a pound. We first put bone black in the bottom of the box, then a layer of the articles to be case-hardened, then another layer of bone black and so on until the box is full. A sheet-iron cover is then put on and sealed with clay to make it air tight and the box put in a furnace built for this purpose.

"We use an oil furnace for this work and I think it is the best, as the heat can be better regulated. We keep the heat up to from 1450 to 1500 degrees Fahrenheit and get very good results. We case-harden ⅛ inch deep in 18 hours and 1/16 inch in 12 hours.

"For the quenching bath we use cold water that is kept cold by a running stream. By this process a good clean job is made and one that is easily cleaned and made bright in the machine shop.

"There is another way of case-hardening that we have practiced for several years. That is, to take about 6 pounds of potash and the balance salt for a box 12x36 inches and pack the pieces in the box. The salt and potash will melt and form a fluid that will boil. For this reason the cover on the box is put on loose so that the steam can escape. We have case-hardened ⅛ inch deep in 8 hours by this process. A small box can be put in the spring furnace when making springs. It will not interfere with this and will save the extra expense of operating case-hardening furnaces.

"When I first started case-hardening with salt I was helping to take the different pieces out and put them in the cooling bath. One of the helpers took a pair of wet tongs and put them in the box of salt and potash fluid and in less time than it takes to tell it the box was empty and I was full of hot salt and potash which burned me all over. Therefore, care must be taken to keep everything wet away from the composition while it is fluid. It is much harder to clean stuff that has been carbonized with the salt and potash than when bone black is used and thus we do not use it now to any extent.

"When a hurry-up job is wanted on an engine in the round house we simply use cyanide of potassium and prussiate of potash. We heat the article to be case-hardened to a bright cherry red, put the potash on with a spoon or rub the cyanide of potassium on with a pair of pick-ups; re-heat the piece so treated and then cool it in cold water. This will go in only about 1/64 of an inch but is useful when the engine is needed."

W. J. Shea, of the I. C. R. R. shops at McComb, Miss., says: "Our method here is to first put a layer of charcoal about 1½ inches deep in the bottom of the cast-iron box; then sprinkle on a layer of ground bone; then put in the pieces to be hardened; then cover them with bone and a small quantity of rock salt. Salsoda is sprinkled in with the bone and also a small percentage of cyanide of potassium; after this another layer is put in in the same way.

"A box 10x12 inches and 36 inches long we heat in an oil furnace for from 10 to 12 hours. This size box is packed with about 25 pounds of bone, 2 pounds sal soda, 3 pounds salt and ¼ pound of cyanide of potassium.

"We have case-hardened large reamers made of soft steel by placing scraps of leather next to the reamer and then packing them as above, and the reamers gave good service. For quick work such as is needed at times in the round house, we use cyanide of potassium and saltpeter for potashing."

George F. Hinkins, Wilmerding, Penn., said: "I have covered this subject pretty thoroughly in former years and will only say now that we have introduced one new feature, and that is reheating the work after it has gone through the old method of case-hardening.

"In reheating we simply place the work in an open furnace heated up to 1500 degrees Fahrenheit, leaving it there sufficiently long to get a uniform and even heat, and then cool it in running water. This adds a higher percentage of hardness, and also restores all inequalities in the structure of the metal.

"I have often noticed case-hardened material that looked crystalline all the way through on small articles and the same was as brash or brittle as overheated and hardened tool steel. I have taken some of these, properly reheated them as above and then broken and found the dark or gray-iron fiber that was missing in the first hardening."

"The success of case-hardening is to harden to the proper depth and retain in a good measure a tough and fibrous interior. This can be accomplished by reheating, as, if your first case-hardening has been overheated causing the material to become brittle, careful reheating will restore or place the material in proper condition."

William Donahue said: "A new method of case-hardening has been brought out by the American Gas Furnace Company, of Elizabeth, N. J., that is way ahead of the old method of carbonizing, owing to the fact that the materials are put into a retort and this is covered up and filled with a carbonizing gas. This system does away with the packing of materials in boxes and hence effects a great saving in that way. It also case-hardens materials to a given depth in less time than by the old process. This recent invention is undoubtedly one of the most important advances that has been made in case-hardening methods, and as it removes many of the main difficulties in the process, considerable advance in the use of case-hardened products may be expected, as, for many purposes case-hardened mild steel is an ideal material. It would certainly pay the members of this association to send to the company for samples, cuts and descriptions of this method of case-hardening."

In the discussion on high-speed steel, J. A. Burkey, Delaware, Ohio, said: "We have annealed a great deal of high-speed steel. To do this we packed the pieces into a large pipe, or case-hardening box, with lime and closed it the same as in case-hardening. We then placed the box in a furnace and heat to a good red heat, continuing the heat for four or five hours, and let it cool off with the furnace over night, after which the steel can be machined as well as any annealed carbon steel.

"Reamers, drills and milling tools we heat in a coke furnace for hardening, and immerse in linseed oil. If the tools prove too hard we draw a temper in fish oil at 450 degrees Fahrenheit. At this temperature we overcome the brittleness and the steel is toughened, so that it will have a keen cutting edge and be protected from any breakage when drawing the tool. By this process you will be sure to have a uniform heat in your tools. If they are polished before drawing you will have a clear view of the straw color you wish to secure."

Many other things of interest were brought out but these are the ones that are of special interest to AMERICAN MACHINIST readers.

Engraving Dies by Automatic Machinery

The Most Delicate and Intricate Designs Reproduced from Enlarged Bronze Castings. Relieving of Raised Die Automatically Accomplished

BY SNOWDEN B. REDFIELD

Die sinking has always been acknowledged to be a work requiring the highest quality of skill for, from the nature of the work which is required of the die to stamp out, it is essential that extreme accuracy should be obtained.

There are many dies used in the stamping out of sheet metal, silverware, both solid and plated, hardware, etc., the designs of which are so intricate and delicate that it would seem to be possible to produce these dies only by the most skilful of hand engraving. There are, however, automatic engraving machines in the market which are used by modern die makers who are doing this class of engraving which produce the most complicated designs in very rapid time and with the employment of little or no hand labor. Fig. 1 is an illustration of an automatic engraving machine made by the Keller Mechanical Engraving Company, of New York, which is turning out the die shown in the center of the picture, this being a reduced reproduction of the pattern shown at the right-hand end of the machine.

The Patterns

Before describing the mechanical engraving devices it would be well to go a little into the matter of the preliminary preparation of the pattern required. In the first place, the designer turns out a sketch showing the finished piece, either silver, brass or other metal which it is desired to stamp into shape with the die. From this sketch a wax model is made up by a modeler, this wax model being as much larger than the desired finished article as may be required by the amount of detailed work to be put upon it. To assist in the making of these wax models, if the general shape of the article is symmetrical or may be turned in a lathe, such as a plate or dish form, the general shape is swept up in half formed plaster and upon this shape the modeler applies wax scrolls, figures or flowers as is required by the design.

This completes the first model and from this a plaster mold is made simply by casting plaster of paris around the model. When a design is symmetrical much labor is also saved by simply modeling one section and then repeating this in the plaster and wax pattern enough times to make the complete symmetrical design.

In order to give greater detail where necessary, it is customary to cast a new complete plaster model in the plaster mold and this model is then retouched by the artist to give the finished details. The pattern or model now being complete, a bronze cast or electrotype is made. Although the machines are extremely sensitive, the best results are accomplished with the use of hard models. If a die (intaglio or female) is desired the pattern must necessarily be intaglio; if a hub (relief or male) is wanted, the pattern must be relief (cameo). In such cases where the reduction is great and the model large a hardened plaster pattern can be used on the machine. The cast-bronze electro or hardened plaster pattern is then bolted on to a revolving face plate on the engraving machine as shown at the right of Fig. 1. This pattern contains all of the minute

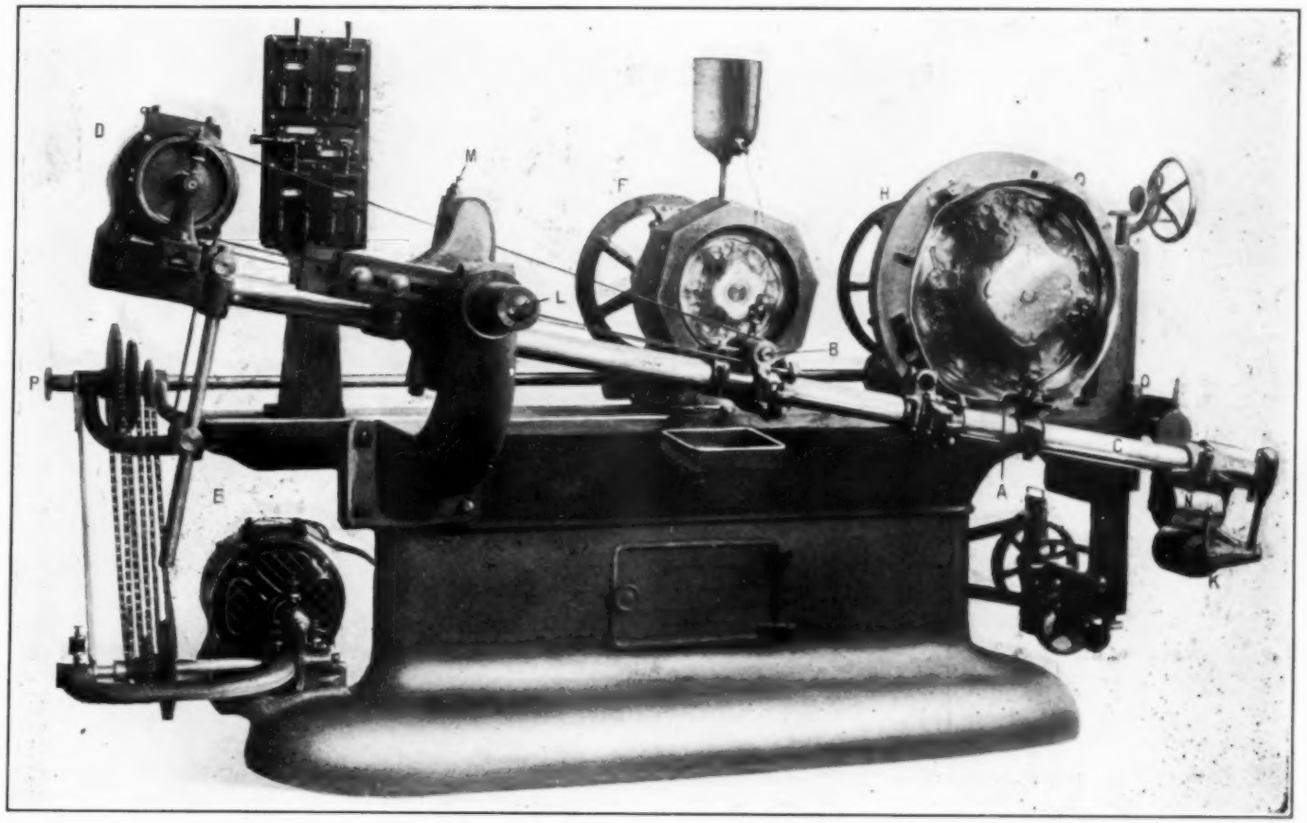


FIG. 1. KELLER AUTOMATIC DIE-ENGRAVING MACHINE

details which it is desired to reproduce in the finished die, which, as already said, will be smaller than the pattern.

The Machine

Now as to the operation of the reducing engraving machine. A long steel bar, *C* in Fig. 1, is so pivoted or fulcrumed at *M* as to swing in a horizontal plane about *M*. It is also pivoted at *L* so that the arm *C* may swing in a vertical plane about the axis *L*. From these two pivots or axes, it is clear that the arm *C* may be swung in two directions about a point on the intersection of the axes *L* and *M*. At the right-hand end of *C*, it is supported by a roller *N* which is in turn supported by the roller *K*. The roller *K* is attached to a vertical slide *O* and by means of the two rollers *N* and *K* the arm *C* is free to swing either in a horizontal or vertical plane without any rubbing friction, as *O* is raised or lowered.

Mounted upon the arm *C* at *A* is a pointed tracing tool and at *B* is a revolving cutter. The revolving cutter at *B* is not much more than an old fashioned cannon drill sharpened to a very acute angle. The shape of the cutter is similar to the shape of the tracer, but the cutter is smaller than the tracer by the exact ratio of the reduction of the finished die from the pattern, which ratio it will be understood is the same as the ratio of the length from the cutter *B* to the axis *M*, to the length from the tracer *A* to the axis *M*.

The right-hand end of the arm *C* is continually drawn in by a weight of a few ounces to hold the tracer point against the pattern and the cutter *B* is revolved at high speed, that is from 5000 to 8000 revolutions per minute by the motor *D* through the belt as shown. The motor *E* by means of the worm gearing and the chain belts drives the shaft *P* and this shaft in turn operates worm gearing which revolves the wheels *H* and *F* which carry on their axes the two face plates, the one containing the pattern and the other the die which it is desired to cut.

Doing the Cutting

To start the action of the cutting, the arm *C* is raised by means of the roller *K* connected to the slide *O* until the tracer *A* rests upon the pattern somewhere near its center. After this the motor *D* is started and the cutter *B* rotating its sharp point upon the steel out of which the die is to be cut, drills into this steel. At the same time the worm wheels *H* and *F* revolve, slowly rotating the two face plates at equal speeds.

As the two face plates revolve, the arm *C* swinging in and out, guided by the tracer passing over the irregular surface of the pattern, gradually drops down at its outer end so that the tracer *A* and the cutter *B* follow out a spiral course over the surface of the pattern and the die respectively. By continuing to revolve the pattern and the die and continually dropping the arm while the pressure holds the pointer against the pattern, it follows that every point in the surface of the pattern is traversed by the tracer and consequently reproduced in the steel of the die by the cutter. This is true down to the minutest detail and the beauty of the work which can be done on this kind of a machine, with its intricate tracery and lines of the finest character, is truly astonishing.

The cutter exactly reproduces the path of the pointer *A* with the exception that the cut made by *B* is reduced in the same proportion as the length from *B* to the axis, to the length from *A* to the axis as already explained, this being the ratio of the relative sizes of the finished die to the pattern.

Cutting Speeds

It will immediately occur to the mechanical mind that as the tracer and the cutter travel over the pattern and die while the arm descends, the linear speed of the tracer and the cutter over the pattern and the steel will be rapidly increasing as they approach the circumferences of the faceplates. This is true and is a very important matter, for if the cutting speed is right near the center, it will indeed be excessive at the outer rim and the quality of the work at the rim will not begin to approach that produced at the center. If the speed were set to be correct at the rim, it would be altogether too slow at the center and not only would time be lost, but again the quality of the work would vary along the radius of the circle. It is thus conceded that the travel of the tracer over the face of pattern must be relatively uniform at all points. If, for example, 15 inches per minute is the correct rate for a certain desired result, this speed or travel must remain uniform throughout.

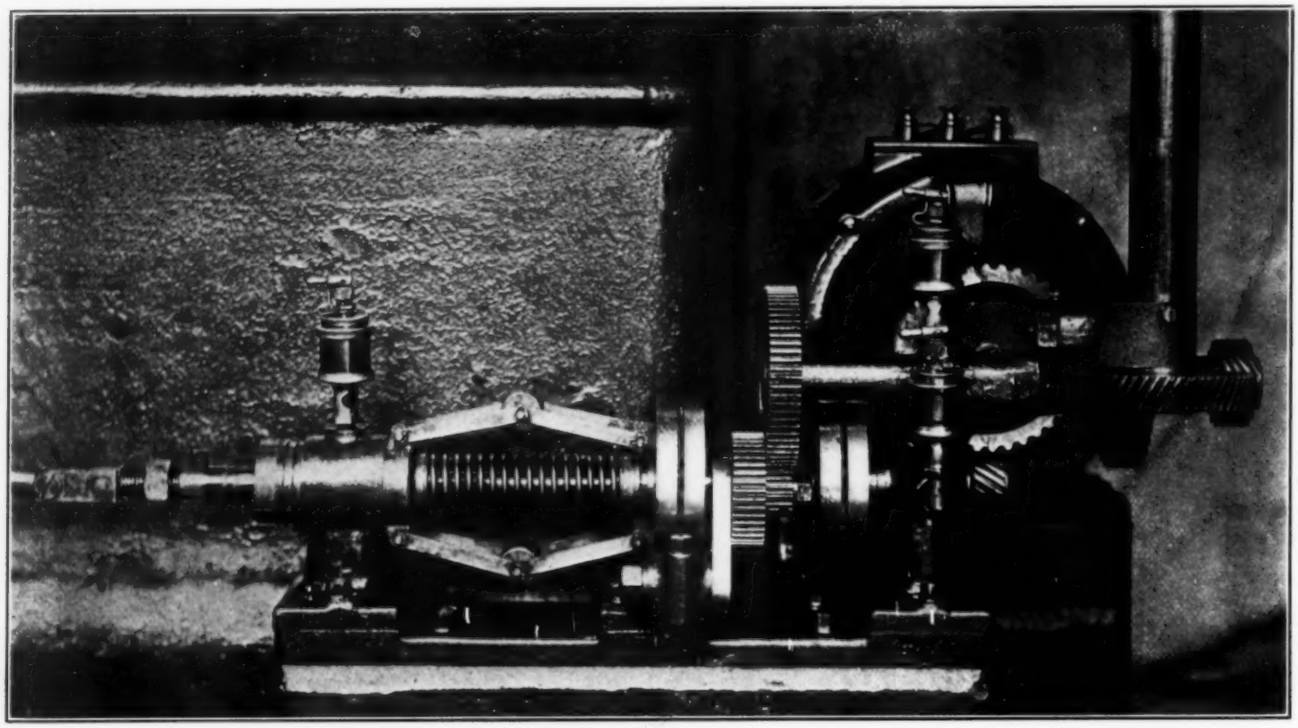


FIG. 2. THE PARABOLIC SPEED-VARIATION MECHANISM

It was at first supposed that a system of cone pulleys giving a variable speed drive to the faceplates would overcome this difficulty, but it was found that the cones did not give the correct speed variation and, while the quality of the work might be as desired at some one point in the radius, it would not be right either at the center or the circumference. Much study was given to this subject and a very ingenious method of speed control was eventually adopted.

Supposing the rotative speed of the faceplates is made correct for the outer rim of the die, it seems that at one-half the radius the speed should be twice as great, because the circumference is only half as long. At one-fourth of the radius, it would seem that the speed should be four times as great. Now the question arises, What ought the speed to be at the center? According to this reasoning it would appear that the center speed should be infinitely great. This of course has to be modified, but it is clear that the speed variation is not uniformly graduated and therefore is not correctly given by a simple system of conical pulleys. As a matter of fact, the speed of the pattern and the die passing across the points of the tracer and cutter as the pattern and die revolve should vary as nearly as possible according to a parabolic curve and the ingenious speed control device with which these machines are provided accomplishes this result in a very pretty manner.

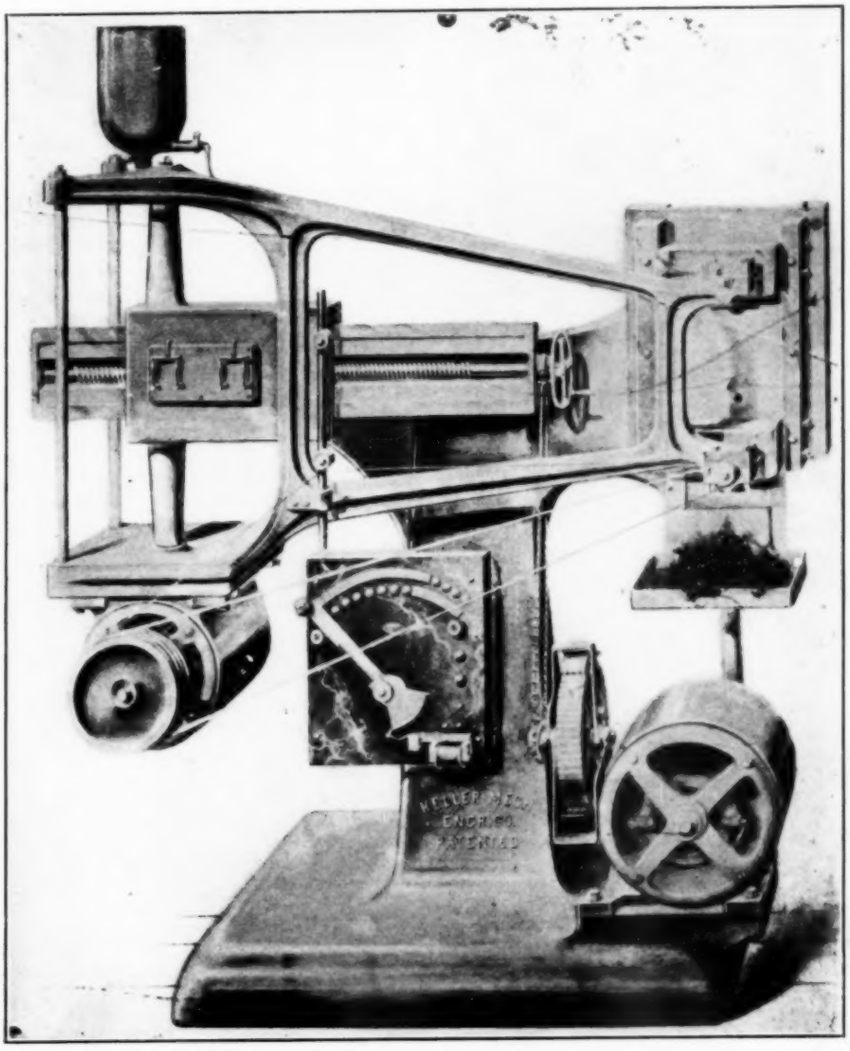


FIG. 3. KELLER DIE-REPRODUCING MACHINE

A Parabolic Variable Speed Governor

Motor *E* drives the countershaft *P* through the chain belts shown, but there is interposed in this system a friction clutch made up of steel disks and cork friction surfaces. The surfaces of this friction clutch are held to a certain degree of contact by means of a small fly-ball governor and this governor is provided with an ordinary helical spring to resist the action of the centrifugal force of the balls. Connecting with the reacting spring there is a lever and a rod which are arranged to vary the tension of this spring, this variation being in accordance with the shape of a special cam which is bolted to the back of the slide *O*. As the slide *O* descends, the cam by means of the rod and lever changes the tension of the spring in the governor so that for a given speed of the governor balls, the grip of the friction clutch varies according to the shape of the cam.

Suppose that starting near the center of the pattern and the work the faceplates are run at their maximum speed. Now as the slide *O* begins to drop, the cam pressing against the lever controlling the governor spring causes this governor to release its grip very slightly upon the friction clutch, allowing the shaft *P* to slip a little with reference to the speed of the motor *E*. Of course if the slipping becomes too great, the governor balls draw in and immediately take a new grip so that the combined action of the centrifugal force of the balls and the varying tension of the controlling spring as produced by the parabolic cam bolted to the slide *O*, give a variation of speed to the shaft *P* and the two faceplates, which corresponds with great accuracy to the parabolic speed curve desired.

As may be surmised, it is impossible to obtain the full range of speed through the governor and the friction clutch, so that there are provided on the machine two sets of change gears. After the full range of speed variation has been obtained with one cam and one set of gears, the gears are changed to give a slower speed and another cam corresponding to these gears bolted on to the slide *O* comes into contact and the operation is continued. In Fig. 1 there are seen three sprocket chains, this arrangement being given to obtain three main fundamental speeds, which in turn can be varied as described by means of the governor. On most of the machines now built, however, but two speed changes are required involving the use of but two sprocket chains, as it has been found that this gives a sufficient speed variation for the most accurate work. The gear changes are accomplished simply by sliding yokes.

In work of this character, where every change of speed from one part of the work to another is more or less plainly visible in the finished product, great care is necessary to keep everything going under exactly the same conditions as far as possible during the completion of the work. It is, however, possible by careful manipulation to even take out the cutter and the tracer for sharpening and to put them back again in such a way that the effect will not be shown. This requires some little skill on the part of the operator.

Relieving the Dies Automatically

In this die work for stamping sheets of metal, the die (or female) and hub (forcer or male) must of course be reproductions of each other with the exception that while the die is recessed the hub is raised. In order that these two surfaces shall be exactly alike, the bronze patterns which are used on the engraving machine

are cast from the same plaster model, the one being from the intaglio and the other from the relief respectively. In this way it will be seen that the two bronze patterns, one being depressed and the other raised, are exact counterparts of each other.

It is well known in practice that sheet metal cannot be stamped from a die and forcer which are exact reproductions of each other if the pattern has depressions or elevations of an angle greater than 30 degrees, without "relieving" the forcer. The term "relieving" means simply the removal of stock from the sloping surfaces of the forcer. The amount of metal to be taken off the forcer depends upon the thickness of stock used for the stamping and the extent of angle of the depressions or elevations. If the angle is as great as 90 degrees the amount to be taken off equals the full thickness of the stock. As this amount varies with the angle, little or no stock must be relieved from forcer of a pattern with gradual elevations or depressions. The steeper the slopes of the surfaces, however, the more they must be relieved to avoid crowding or upsetting the stock of the stamping. The space between die and forcer remains practically uniform throughout. The dies (female) are rarely relieved.

To accomplish the above result on the machine it is only necessary when cutting the forcer to use a cutter with its point a little larger in diameter than the one used in cutting the die. It will thus be seen that a little more stock is taken from the straight and sloping sides of the forcer than from the die.

FIG. 5. AN EXCEPTIONALLY FINE PIECE OF ENGRAVING. FULL SIZE

From this will be seen the importance of the cutter diameter. In fact, the diameter of the cutter at the cutting point is very accurately measured in a micrometer machine especially designed for the purpose, so that it will be smaller than the point of the tracer by the exact amount that it is desired to reduce the size of the pattern in the finished die. This ratio is again the same as the ratio of the lever arms of the cutter and the tracer on the swinging arm, as shown in Fig. 1.

Irregular Shapes

So far, we have considered the cutting of more or less round figures, but these machines are used for cutting dies having any contour. Take, for instance, a silver back for a hand mirror. The dies for stamping this will, of course, be of irregular shape corresponding in outline to the shape of the mirror back.

For doing this work, the pattern is clamped onto the faceplate as before, and the tracer and cutting tool started near the center of the figure of the pattern and the die to be cut. The first cuts made are small spirals which grow larger and larger and on the narrow part there will soon come a time when the tracer is outside of the boundary line of the pattern. When this has happened, all the time taken to traverse the outside surfaces is wasted, so that the operation of the machine is slightly changed.

An electric switch is thrown into connection with a tripping lever on the faceplate, so that when the faceplate has revolved a certain distance, the lever re-

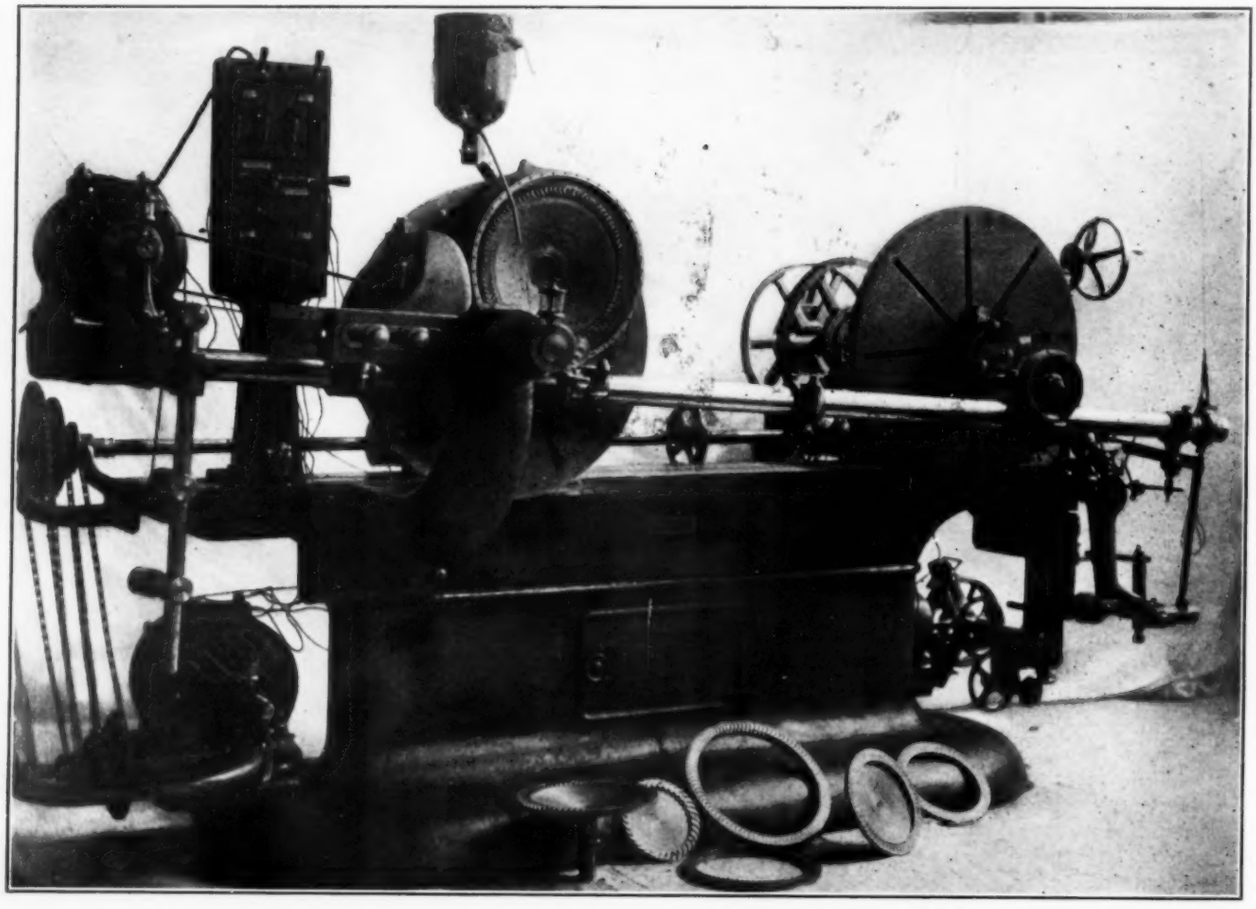


FIG. 4. CUTTING STEAM TURBINE BLADES ON AN ENGRAVING MACHINE

verses the switch which in turn reverses the motor driving the faceplates. These, then, immediately turn back in the opposite direction until another stop is reached, when the motor is again reversed. In this way an oscillating motion is given to the faceplates and the tracer and cutter describe swinging arcs whose lengths are only slightly greater than the width of the pattern at that point.

When the work has been completed at one end of the pattern in this way, the faceplates are turned on their axes so that the pattern and die are the other side up and the oscillating motion is continued while the tracer and cutter follow out the surface of the other end of the design.

Sensitiveness a Prime Requisite

For some classes of work where the depressed and raised portions of the pattern are very deep, it is necessary to use a revolving tracer, as well as the revolving cutter, but it is really astonishing to note what steep surfaces the ordinary stationary tracer point will climb so that the revolving tracer is not very often necessary.

The amount of pressure put upon the swinging arm *C* to hold the tracer against the pattern and the tool against the work is rather important, as if the pressure is too great, both the tracer and the tool become worn, and this is shown in the work produced. For this reason the pressure is made as light as possible, and is, in fact, but a few ounces. Under these circumstances it is necessary to have the swinging arm as free as possible from any external tendency to swing it in any direction. This is the reason for providing the rollers *N* and *K* in order to do away with any slight friction.

Aside from this it will be noted that the motor *D* driving the cutter *B* is mounted directly upon the arm *C*, and the drive is by means of a belt. The machines formerly manufactured were driven by a motor, which was mounted on the main frame and the belt passed around a number of pulleys before reaching the cutter. It was found that even with the very slight in-and-out swinging motion of the arm *C*, a different tension was given to the belt driving the cutter, and this tension affected the pressure brought to bear upon the tracer, and this in turn reduced the sensitiveness of the machine. As at present built with the motor mounted directly on the arm and the arm supported by the rollers, the tracer and the cutter appear to be about as free from external influences as it is possible to imagine.

Of course, the positions of the two faceplates are adjustable along the base of the machine, and the relative position of the tracer and the cutter are also adjustable along the length of the bar. The object of this is to give any desired amount of reduction in the size of the work, and in order to facilitate this a finely divided scale is provided along the bed of the machine, measuring from the axis of the spindle carrying the pattern to the swinging center *L*.

Wherever it is possible to do so, the heavier cuts on the dies produced are made in a milling machine using an end mill. This procedure saves considerable time for the engraving machine by taking off much heavier cuts, and also saves wear on the cutter.

To produce a fine character of finish, the engraving machine goes over the work at least twice, the first time using a coarse tracer and cutter, taking comparatively heavy cuts, and the second time going over the surfaces with finer tracer and cutter points and using a much slower speed of the faceplates, producing a much finer cut and a better surface.

A Reproducing Machine

Fig. 3 is an illustration of an engraving machine used for reproducing a given

FIG. 6. DIE FOR SILVER BRUSH BACK. HALF SIZE

pattern or duplicating work that has already been cut, in exactly the same size. The principle of this machine is the same as that shown in Fig. 1, with the exception that the position of the tracer and the cutting tool relative to the pivot of the swinging arm is the same for each. In this way it is clear that the size of the work will be the same as that of the pattern. In the illustration it will be seen that the tracing tool is at the top of the right-hand end of the frame and the cutter is at the bottom. The whole arm swings in and out about the vertical axis at the left end of the arm, and at the same time the motor at the bottom alternately raises and lowers the slide just back of the tracer and cutter. This sliding motion takes the place of the rotating motion given to the pattern and the work by the machine, shown in Fig. 1. In this way, the tracer and cutter follow over the entire surfaces in straight parallel lines instead of in spirals or arcs.

Reduction in size as obtained with the reducing machine is a great advantage, as by this means very fine work may be produced from a large pattern easily handled by the modeler. The duplicating machine is used only when a duplicate of a finished article is desired, this article having all the fine work in it originally cut by the reducing machine.

Cutting Turbine Blades

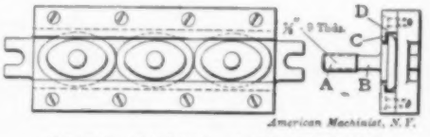
Fig. 4 is an illustration of an engraving or die-cutting machine which is cutting turbine blades. At the right-hand side of the picture it will be seen that the tracer is caused to follow around the periphery of a sheet-metal templet, this templet being an enlarged reproduction of the turbine bucket, which it is desired to cut by the revolving cutter. This is a most interesting application of the engraving machine, although it is not as yet commercial practice.

Besides making the dies for stamping sheet metal, such as silver or brass ware, the engraving machines are also used for the cutting of dies for coins, medals, etc., and the high quality of the work which they are able to turn out now, not only rivals that which can be produced by the most skilful hand operators, but far outclasses it.

Threading the Studs in Washout Doors for Boilers

By Robert Brown

Herewith is end elevation and plan of a simple rig made for holding washout doors for boilers, when being threaded at *A*. The door is well shown in the end elevation, and is an ugly piece to hold for threading quickly. Till this method was adopted they had always been done with single-pointed tools in the lathe. The door is a drop forging and is 7/8 inch diameter at the end of *A*, tapering to about 15/16 inch at the neck *B*. The neck



JIG FOR HOLDING WASHOUT DOORS

was first reduced in the engine lathe with a forming tool which left a good fillet close to the door, after which *A* was threaded in the drill press.

The jig was bolted to the drill-press table and the geometric self-opening die head was carried and driven by an adapter in the drill spindle. One cut finished *A* to size, and no time was lost in returning the die head ready to thread another stem. As it did not run very fast no trouble was experienced in closing it by hand. It will be noted that the door is an easy fit at *C* and *D*.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Boring Mill Fixture for Holding Cams

The sketch shows a fixture designed to center and hold the cam shown for boring in the vertical boring mill. It is equally applicable to pulleys, gears, or similar parts, particularly such as have rims too light to be safely held in the ordinary chuck. Fig. 1 shows the fixture with the work *W* fastened in place, and Fig. 2 shows the fixture alone ready for a casting to be put in. The body of the fixture is a cast-iron plate *A* having a projecting ring turned on its lower face to center it, and three holes *O* to receive bolts to fasten it on the faceplate of the machine. In the upper face a groove is cut so that the ring *B* sets in flush with the top of the plate. This ring has three slots cut in its periphery to fit the rollers *C*, which are fastened to the bottom of levers *D D* and *D'*. The lever *D'*, shown in detail in Fig. 3, is the same as levers *D D* except that its outer end is left longer to provide room for knob *E*. The levers are pivoted on screws *F* and on their upper faces have rollers *G* which bear against the circumference of the casting.

Three clamps *H* are provided, which rest on posts *I* and bear on the work directly over pins *J*. The detail of the clamp, Fig. 4, shows the elongated hole for the stud and a slot in the bottom, fitting over a pin in a post, which permits of sliding the clamp back while preventing its turning.

In use the fixture is first arranged as shown in Fig. 2, with clamps drawn out and levers set radially. The casting is then put in, resting on pins *J*, and lever *D'* is swung around by grasping knob *E*. This, through ring *B*, swings levers *D D* and brings rollers *G* closer together until they touch the outside of the cam. Block *K* swiveling in plate *A*, is then turned up and screw *L* brought up to hold the levers in place. The circumference now being true the clamps are slid in and tightened, holding the bottom side of the cam true against the three pins *J*.

The casting is thus set true and firmly fastened, and is ready to be bored and reamed. A number of these fixtures are being used on the vertical turret lathes and have proved very rapid and efficient.

Albany, N. Y. T. R. STARK.

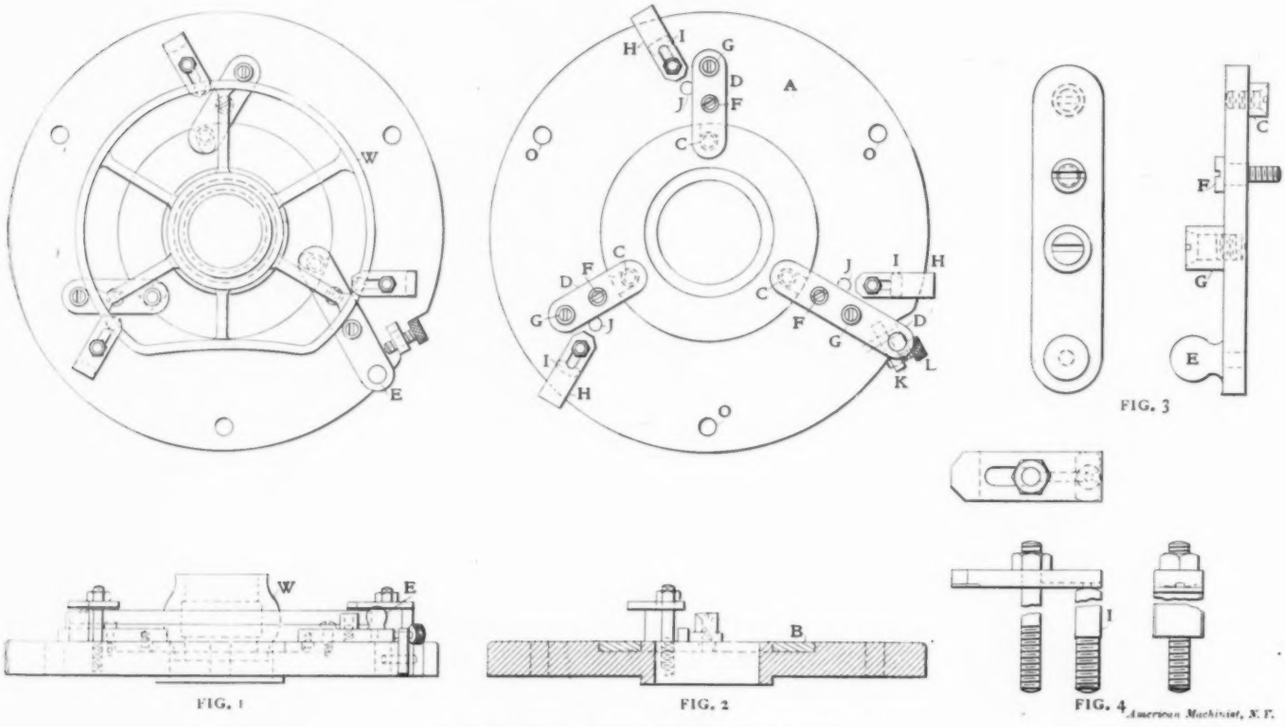


FIG. 1 FIG. 2 FIG. 3 FIG. 4

BORING-MILL FIXTURE FOR HOLDING CAMS

High Speed Steels, the Brazing of Cast Iron and Hand Milling Tools

Since the high-speed steels have come into such general use there is an acknowledged advantage in their use which I fully appreciate. But what I wish to call attention to in this article is that there are many conditions in the average modern shop that the steel makers do not say much about.

They tell us how many feet per minute their steels will cut at a certain feed and depth of cut on certain grades of material.

In many places there is necessarily a large amount of stock that must be removed, but we plan to have just as little stock to be machined off as possible, and very often it is not how heavy a cut the tool will stand, but how coarse a feed and how fast a speed on casting scale, that has more or less hard spots, will it stand, and how good a finish will it leave?

While I understand that the steels that will remove the greatest amount of clean stock will usually work proportionately better under the above conditions than a

poorer grade, yet I would be better able to select the grade that would meet my requirements best if the makers would tell me more about tests made under similar conditions.

A few months ago a representative of a firm who sells a brazing compound and equipments for brazing cast iron, came around with a lot of brazed samples for prospective customers to break, that they might see that the break always occurred somewhere outside of the brazed part. It occurred to me that they broke somewhat easier than they would have done before being brazed, as though the brazing process had rendered the metal in its immediate vicinity somewhat brittle.

However, the brazing of cast iron is a thoroughly practical thing to do in many cases. But it is frequently done on brackets and frames that are so badly warped by the brazing process that the work afterward of refitting and straightening is as much or more than it would be to make the part new.

And in many cases castings get broken, not in their regular use, but by some accident which is not likely to occur again. The repairing of such by brazing, even though they are not as strong as they originally were, is satisfactory.

The hand-milling tool (in the form of a file) that has recently been brought out fills a long-felt want, and is a surprise to most everyone when they first use it.

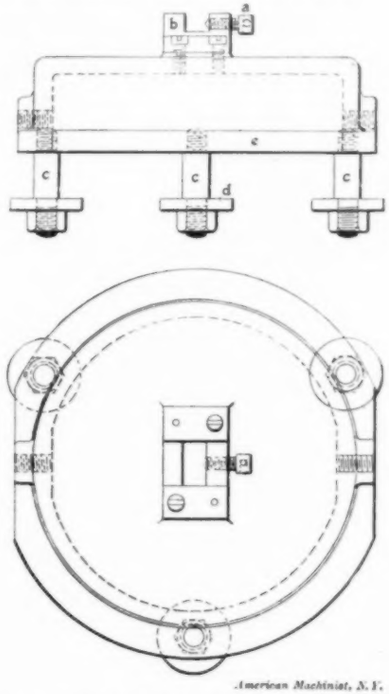


FIG. 1. BASE PLATE OF ENGRAVING MACHINE

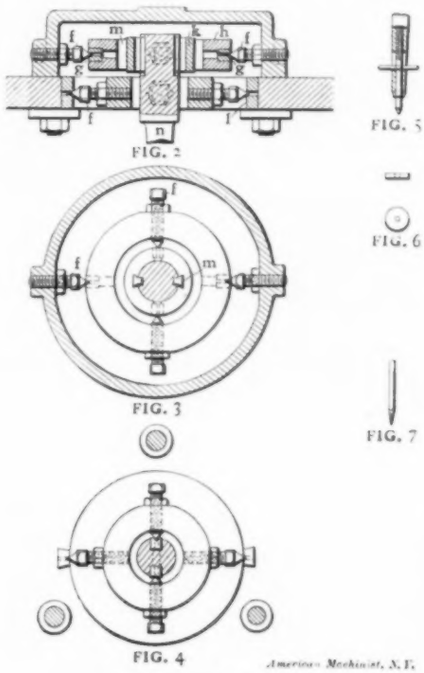
I believe there are but few shops that use files at all that can afford to be without them. But when the salesman is showing us how fast and easy it will remove a large amount of stock we sometimes are so enthusiastic about getting hold of all the new and good things that we may forget that we should remove all the stock that we possibly can with the machine tools, and that filing even with the best of files is a slow and unsatisfactory job, and the amount of it done should be as small as possible consistent with good work.

I speak of these things to show how necessary it is for us to do our own thinking. It's perfectly natural for the carpenter to repair all things with wood, and for the blacksmith to use iron to make the same repairs, but it would be equally unwise for us to give all our repair work to either the one or the other, and for the same reasons we must look very carefully into the conditions which we have to deal with.

Watervleit, N. Y. JOHN MARK MAY.

Cutting Steel Figures on a Drill Press

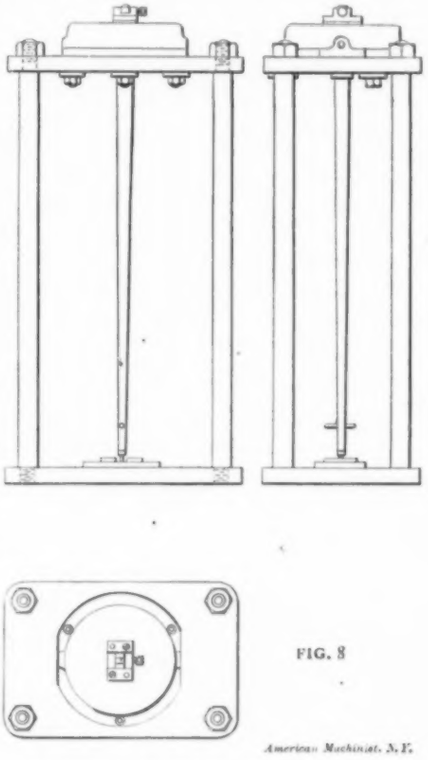
Having read several articles on letter cutting in the AMERICAN MACHINIST, I thought the following might be of interest.



SOME OF THE DETAILS

The pieces to be cut were of tool steel and afterward hardened. Some thousands of these were required for some ticket punches we were making, and they are being used on the Egyptian State railways at the present day. The pieces were held in a holder and then put in position and clamped by the screw *a*, in Fig. 1. This also shows the moving platform, which consists of an iron casting, fitted on top with a receiver for the holder *b* and on the underside with three studs *c*. The length of the plain portion of these studs was made so that when the nuts were screwed up hard the distance between the upper face of the washers *d*, and the lower face of the casting *e*, was such as to allow the casting to slide on the top plate without lifting.

Fig. 2 shows the construction for obtaining the desired movement, and needs but little explanation. The screws *f* were of tool steel and hardened at the pointed end, and the bushes *g* were also of hardened steel, driven into the mild-steel ring *h*, and sleeve *k*. The pieces *l* were hardened, and dovetailed into the upper plate. Keys *m* were fitted to the sleeve *k*, and were made a good sliding fit in the actuating rod *n*. Fig. 3 is an inverted plan of the top joint, and Fig. 4 a similar view



MACHINE IN PLACE ON DRILL PRESS

of the lower joint. The holes in the top plate through which the studs *c* pass, were made sufficiently large for the movement required.

The lower plate was made the same size as the upper plate, the two being connected by four pieces of mild-steel bar as shown, Fig. 8. The lower end of the actuating rod is shown in Fig. 5, and is bored to take a piece of drill rod, which is pressed down by the spiral spring. A piece of wire passes through a slot in the actuating rod and through the piece of drill rod, so that the latter can be raised with the fingers. Fig. 6 shows a mild-steel disk, of which several were required, varying in diameter to suit the depth of cut required. These disks have a small hole in the center to take the pointer, shown in Fig. 5. For master figures, we purchased some brass figures as used by pattern-makers, and filed them to an even width all-round. This rig was used on a sensitive drill, which had to be speeded up considerably, and a thin cotton belt used in place of the thick leather one.

The cutting tool was a piece of wire ground as shown in Fig. 7, and, of course, was hardened. Fig. 8 shows the rig assembled. In operation, this rig was bolted to the table of the drilling machine, the master figures being attached to the lower plate. The tool was set to the correct depth, and the largest disk was run around the master figures, the pointer of the actuating rod holding the disk. The next largest disk was then run around, and so on until the figures were finished. In the case of such figures as 8, 6, etc., a small drill had to remove the center portions, the V-tool being used for finishing. This rig turned out a first-class job, and in the absence of an engraving machine served a very useful purpose.

E. J. JOHNSON.

London, England.

Fine German Locksmithing

As when the Düsseldorf exhibition was opened with eclat by the German crown prince, the latter, in a fine speech, congratulated his future subjects upon the marvelous progress they had made and were still making in the industrial and fine arts—it is no more than right that American manufacturers and workmen should know—particularly if they wish for foreign trade—what sort of rivalry they have to encounter in the land of the "Pickelhaube." This is all the more important in view of the fact that American apples have been excluded from competition with the luscious fruits of the sunny mountains of Brandenburg, and American beef, which is only good enough for "Englander," has also been shut out from German ports as not fit to be seen on the same day with the tender Rindfleisch of the Brandenburg highlands. We must have some chance to make a penny out of the Germans, and if their mechanics are going to beat ours out of their boots on their own ground, there will be nothing left for "we'uns" to do but find a nice small knot hole, crawl into it, and pull it in after us.

This being the case, I send you a small valise key, which was made at the principal "Schlosserei" in Hanover (population, including Linden, which is continuous therewith, about 280,000). It was delivered, in company with a duplicate made at the same time, without any hole in what would otherwise have been the "bow;" the reason probably being that the Germans have the idea that all Americans carry all their keys in their pocketbooks, or at least in their vest pockets. As it is my custom to carry all American keys on a ring (I have now a small truck for the German ones, the wheelbarrow was unhandy) I ordered holes made in these, so that they could go on my keyring along with the American ones. This work, however, I had done in a leading establishment on another street (It is well to distribute one's custom so as not spend too much money in any establishment. Also, one learns where the best work is done). The effects of the early medieval artist workman may still be seen in the sample, sent herewith, of their successors' loving handiwork. This goes to show us what one can do if one has an ideal and follows good masters. The modern tendency, "secessionist," so called, has, however, had an influence upon the German workman of the present day. The leaven of the industrial-art schools has evidently penetrated here. This is seen in the departure from stiff regularity in the form of the bow, and in the eccentricity of position of the hole. The hole itself (I regret the inability of a mere halftone engraving to do justice to this work of true art) shows what skill and ambition can accomplish when the ideal is high, and the taste has not been contaminated with the stiff outlines turned

GERMAN FINE(?) LOCKSMITH WORK

out by American shops. Seen from one side, the hole is countersunk and the surface smooth; from the other side, however, there is a delicate fin, which gives variety, and also aids the owner of the key to tell, even in the darkest night and with gloved hand, which side of the key goes toward the right.

You will pardon me for taking up so much of your space, and you will, I hope, relieve me of all imputation of being an alarmist, but I feel it my duty to our Yales, Corbins, Millers and Eagles, and all the rest of the struggling American lockmakers, as well as to our locksmiths, pure and simple, wherever they may be, to point out the work that Germany, the industrial center of the world, can attain without half trying.

I beg you not to use my real name, as it might create unpleasant feelings on the part of the American lock manufacturers and mechanics, against one who prefers to sneak behind the modest nom de guerre of ARTIST ARTISAN.

Hanover, Germany.

Hours of Daylight and Working Hours

I notice that a daylight-saving bill is before the legislature of one of the States in the Middle West. These bills crop up every little while, but I never took any interest in them until this summer. I have a sleeping room that faces eastward and has no blinds. I began waking at 5 o'clock and found the sun shining, much to my surprise. Also I got acquainted with the milkman, who had previously been a rather mythical being whose presence was only inferred from certain periodic happenings rather than from actual contact. He said the sun rose ahead of me a large part of the year, and that if I rose when I ought I would have time to do some work before supper. I hunted up an old almanac and verified his statements.

It seems that for seven months in the year the sun rises before 6 a.m. This daylight law seems to be a scheme to take advantage of this happening, which has been going on so long as to be a habit. The idea is that if everyone got up a little earlier and went to bed a little earlier that it would cost less for gas and electricity and Standard Oil and tallow candles, and so on. The shortest day of the year is nine hours and four minutes long. If your employer asks you to get to work at 7:13 a.m. and quit at 4:13 p.m., with an hour for dinner, you get in eight hours and he gets all the daylight time you have except two minutes at each end of the shortest day. If it were not for cloudy days he would not have to have a lighting plant at all, which would be excellent for him.

If you are running on a nine-hour schedule from November 9 to February 1 you have no daylight of your own. In November you work from 6:30 a.m. to 4:30 p.m., and February 1 shift to 7 a.m. to 5 p.m. In the meantime it makes no difference to you what your hours are, but quite a bit to your employer. The 10-hour day is worse yet. If you try that from October 17 to February 24 you cannot see the sun except at noon, and your schedule of work is 6 a.m. to 5 p.m. in October, and 6:30 a.m. to 5:30 p.m. in February.

All this simply indicates that we are not in the habit of getting up and getting to work early enough to get the full value of our sunlight. What appears to fix our working hours is the old, old custom of having dinner from 12 m. to 1 p.m., and then balancing the working day each side of that. In almost all cases where the dinner hour is varied from that it is pushed ahead to 1 to 2 p.m. instead of doing the logical thing and having it between 11 a.m. and 12 m. Custom is so strong that the reformers think it will be easier to move all the clocks ahead an hour than to get people to change their habit, which principal habit is watching the clock. So

few people have sun dials now-a-days that possibly it would not be very troublesome to do this. If it was generally accepted that this was the proper thing it could be as easily done as was the case when railroad time was adopted.

So far there has been no very general demand for such a change. In fact, there are a lot of us that like to sit up late nights. Even the little Entropies tease to sit up later and later every year. Some of us like to work better at night anyway. In spite of my milkman's sarcasm I do get in a day's work usually, even if quite a bit of it is after supper. If it is true that people prefer to use artificial light a good part of the time then it must be classed as a luxury. If we can afford it, then it is nobody's affair. Except for fireflies, we are the only animals that make artificial light, so possibly we ought to use our privileges.

Springfield, Mass. ENTROPY.

A Stud Releasing Device for the Flat Turret Lathe

As an operator of a Jones & Lamson turret lathe, I am called on to make large numbers of studs, ranging in size from ½ to ⅞ inch for gas-engine work. The making of a stud is a very simple and easy thing, but the monotony of it leads one to thinking of means to get around the undesirable features of the work and to facilitate the output. Figs 1 and 2 show an apparatus which I have made for releasing the driving nut from the stud after the thread is cut. The parts of Fig. 1 not section lined show the regular automatic chuck of the Jones & Lamson lathe. *P* is a circular plate recessed to fit over the flange of the chuck to hold it central with it. It also has a projecting ring *X* which carries part *B*. The plate *P* is provided with two pins *M* and *O* on opposite sides of it. *M* serves to drive the plate *P*, being inserted between the jaws of the chuck for that purpose. *O* releases the pawl *D* from engagement with *A* and serves to back the driving nut off the finished stud. *S* and *N* are the driving stud and nut respectively. *B* is a collar fitting the nut *N* loosely and having a pawl *D* which engages *A* when the spindle is run backward. *A* is a stationary ring in which *B* rotates and is held from turning by the round bar *T*, which is secured to the casting carrying the speed-variator levers of the lathe. *C* is a collar attached to the end of the driving nut *N* and held by the set screw *E*. *R* is a spring which holds *A* and *B* in place against the plate *P* and at the same time gives the nut *N* freedom to back off the stud *S* when the stud is released.

In putting the attachment in place, I put in the chuck, three jaws and two separators, the pin *M* going where the third separator should. The driving stud *S* and nut *N* are put in and the chuck closed. Turn spindle until pin *O* is on the top. Screw the nut *N* up against the plate *P*. Slip *A* and *B* in place with the pawl *P* on the bottom side. Put on the spring *R* and the collar *C* and it is ready for use.

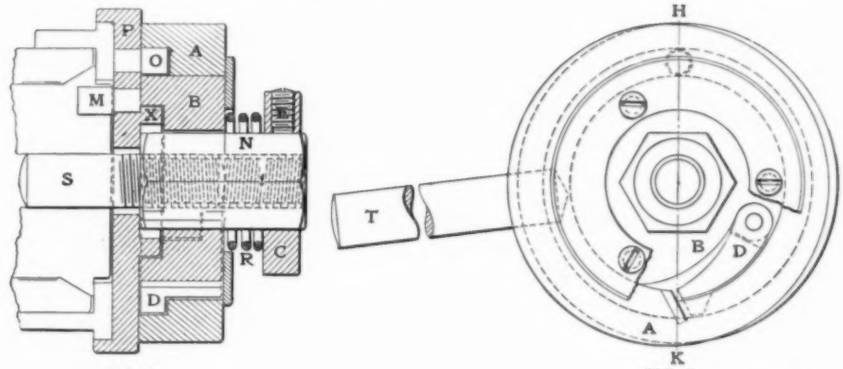


FIG. 1 FIG. 2

American Machinist, N.Y.

STUD-RELEASING DEVICE FOR THE FLAT TURRET LATHE

The nut ends of the studs are cut first and are made loose enough so that they may be screwed into the nut *N* with the fingers. Start the spindle forward, place a stud in the nut *N* with the fingers, set the die up and cut the thread. Then reverse the spindle, and during the first revolution, the stud is released from the nut *N* and may be taken out by holding it in the fingers while the spindle runs back.

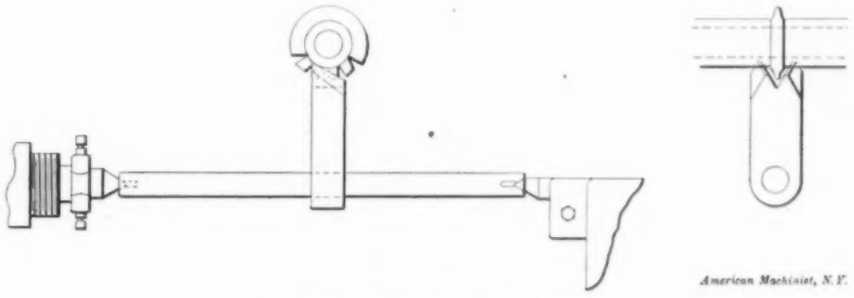
The principal parts of this attachment, namely *P*, *B* and *A*, were made from bar stock, pieces being sawed off of suitable length and finished in the turret lathe, the driving stud *S* and nut *N* being the same as heretofore used. The driving nuts for the different sizes of studs being the same external diameter, the attachment fits all of them.

Astoria, Ore. W. WHITLEY.

A Gear Cutter Centering Gage

The cut shows the device used in our shop for centering gear cutters. While several tools designed for that purpose have been shown in these columns, I believe this has some advantages.

The gage proper slides on a ground arbor held between the dividing head and tail center on the milling-machine table. The V-slot for the cutter in the upper end is cut straight—that is, in line with the axis of the arbor—but the points are cut off at an angle, leaving the V smaller at one end. This permits its use with fine pitch cutters where the points of a large V would strike the arbor collars.



American Machinist, N.Y.

A GEAR-CUTTER CENTERING GAGE

The centering, of course, is done by setting the sides of the gage vertical with the aid of a square. The device is convenient to use in that once it is under the cutter it holds itself in position, leaving the hands free to handle the square and adjust the machine.

Brooklyn, N. Y. T. SQUARE.

When the growing scarcity of timber is called to attention the common thought is that suitable substitutes for wood in building and structural work is the only salvation, and in this connection it is significant to note that inroads into our forest wealth are made from other directions as well. The wood-pulp industry in this country has become a large factor. In the 251 wood-pulp mills operating in this country last year, 3,346,106 cords of wood were converted into pulp, of which it is noted that 64 per cent. was spruce. This industry has developed so rapidly during recent years that the domestic supply of spruce, the desirable specie for the purpose, has proved inadequate, and large importations from Canada are made. Hemlock and poplar are used in the next largest quantities, no less than 90 per cent. of all the wood used for pulp-making purposes coming from these three species.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

The Temperature at Which to Quench Tool Steels

I can hardly leave Mr. Osborn's kind words at rest, even though I am tempted to try to absorb all the glory that James Steel is receiving, especially in Mr. Osborn's article on page 77. I have done my best to make James Steel a famous writer, and will only protect his statements insofar as it does not lead me into a clash.

Should I get seriously tangled in dealing with carbonless iron or ferrite, and subsaturated steel, and be tossed about mentally by some molecular disturbance, caused by the steel being heated beyond the coalescence point, then I may long to get behind the fame of James Steel and have a few moments rest.

With all due regard to those who have failed with some of the late products of science in heat-treating steel, let me say awake, get busy and try again; it may not be too late to learn how to use them. Here let me quote from J. Kent Smith under the heading of "Heat Treatment of Vanadium Steel," but before doing so let me say that vanadium steel will stand more abuse in forging, etc., than any of our carbon steels intended for tools. Yet hear what this, a trained analyst, metallurgist, and practical steelmaker has to say. It is simple, yet he finds it of value:

"If heat be applied to a bar of normal steel, it will become sensibly hotter with each successive increment of heat up to a given point. Thereupon further application of heat causes a molecular rearrangement, instead of increasing the sensible temperature of the steel; the pearlite becomes broken up, its carbides going into solid solution in the ferrite. When such decomposition and solution are complete the sensible temperature of the steel again rises as heat is applied.

In cooling the steel, the converse takes place. To a certain point the steel cools regularly; then it apparently ceases to cool, its dissolved carbides being thrown out of solution, and alloying themselves with ferrite to reform pearlite when the carbides are completely thrown out of solution sensible cooling again regularly proceeds. Such is a brief explanation of calescence and recalescence.

Is it any wonder that Mr. Osborne is anxious to go to the bottom of the subject? He is quite right in understanding me to say that should several tools be made identical but from different steel, each might require a different degree of heat from the calescence point. I have found that this must be due to something other than the carbon, providing the carbon was what it was claimed to be.

I have no desire to discuss any rule governing the best quenching point, from the calescence point, in the hardening of tools, but I have no hesitancy in giving the readers of the AMERICAN MACHINIST my methods of procedure in determining just what heat will be the best to quench at, to produce the best cutting grain, together with the greatest degree of hardness from a piece of steel cut from a certain grade.

The reader must not be led astray by the above statement as the two heats cannot be considered together. First; we must find this quenching heat. Then we must work as close to it as is possible when hardening tools. Second; the size, distortion and design are factors that must receive consideration previous to deciding on the best heat for the greatest hardness, or cutting qualities.

All decarbonized stock being removed from the test pieces, I commence to heat and harden them to certain temperatures, as registered on the pyrometer, but do not heat any part of the test pieces more than once, as this would be refining and increasing the efficiency of the steel.

After hardening each test piece at a different temperature, I break them until I find the grain that I think is the best.

Then I take three pieces, one of each grade of steel being tested, and harden at the heat that has been determined by the test. I then take one piece from each grade and draw it to 400 degrees Fahrenheit. The second piece from each grade I draw to 410 degrees and the third to 415 degrees.

These are then tested on the sclerescope for hardness, and if I have lost five points in the letting down, or drawing, of any of the pieces I return again to my first test and add more heat. If I have lost five points in hardness, I add 18 degrees Fahrenheit in heating. If ten points are lost in the letting down, I add 35 degrees to my quenching heat.

This is continued until not more than 3 points are lost; then the test pieces are where I know it will require considerable heat to break them down in use. At the same time I have a good grain and do not look for improvement by any additional heat, nor does it happen that the heat is to be lowered. We usually find the steel to be at its best after this test is fully carried out.

After this we take one tool of each grade of steel being tested, give them a uniform grinding and put them to work at a moderate speed that is continued until the tools are broken down or destroyed. If there is any material difference in any of the pieces being tested, the weaker ones are given continued trials and if they cannot be made to equal the best record produced in the test, we begin to think we have found a difference in the adaptability of the steel and discontinue our tests of hardening, and test for the calesence point.

We find ordinarily that the best hardening heat is from 20 to 35 degrees Fahrenheit beyond the calescence point, but in some instances we find the best heat to be as much as 90 degrees above. We do not look for the calescence point first, in the hardening, but in the annealing we do.

Should we take two grades of steel, harden them at 18 degrees Fahrenheit above the calescence point and draw them both to 415 degrees Fahrenheit and find a noticeable difference in the hardness of the two, it proves that the softer requires a higher heat above the calescence point than the harder tool. This shows that we cannot heat every grade or make of steel to the same degree above the calescence point.

Should all tools do their best when just hardened and not let down, we could stay considerably closer to the calescence point and a more uniform rule might be given as to how to determine just how many degrees above the calescence point produces the hardest tool.

To treat this subject in another way, let us suppose that we have a comparative test to make of two steels with the same carbon contents, yet of different makes. We would hardly be censured for hardening both pieces at the same heat; in fact, most anyone would be satisfied with that treatment of their steel. To me, however, this is not fair, because it is not the correct treatment. We may have proceeded correctly for one piece but not for both.

The first thing should be to heat and harden and then draw and test for hardness.

On account of the chemical composition of some steels, they will harden extremely hard at a low heat, but will lose hardness rapidly when being drawn back; but when more heat is added when hardening they become less liable to such great loss in the letting down.

The tool requiring the greatest amount of heat to cause the greatest reduction in

its hardness will be the best tool. This is why we do not look for the calescence point previous to the hardening, but as stated, should there be too great a difference in the results obtained in the cutting test, then the calescence point is taken up. Usually the drawing test holds good and the speed has to be reduced to a point where the tool will not heat to the breaking-down point; it being hard enough to cut at a slow speed, but will not stand up under a speed that will heat the tool to 430 degrees Fahrenheit.

Some may want to know what is considered the best cutting grain for a tool, but it would be just as easy to answer that as it would be to recommend a special heat for steel of, say, 1.25 per cent. carbon, when you know nothing of the other ingredients.

If we could name a special make of steel without the reader forming the conclusion that it is necessary for him to use that particular make of steel, in order to be able to follow the instructions given (which is true); then I could say heat A's steel to 1463 degrees Fahrenheit, quench in brine and you will have the steel with its best cutting grain and hardest point.

While the composition is the one controlling element, different steelmakers use different compositions. Thus we are forced to disregard the calescence point when determining the best heat for tools. This is very noticeable in alloyed finishing steels.

While some steels, of precisely the same carbon contents, will vary from 20 to 65 degrees Fahrenheit for the best hardening heat, we find in heating high-speed steels for hardening that some will require 200 degrees more heat, to get the best results, than others. It is my opinion that the microscope will be found of great value in determining the heat to be given for quenching; in fact, I consider it the only reliable instrument for this work.

Davenport, Iowa. C. U. SCOTT.

The Commercial Value of Patents

Your article, in a recent number of the AMERICAN MACHINIST, on patents and their commercial value, was good and timely. The comments by various patentees seem to bring out some defects in the patent system that, from a business-man's standpoint, might and should be corrected for the benefit of the community to the mutual advantage of manufacturers and inventors.

An inventor should be worth as much to the community as a farmer, class for class. There are good and bad of both classes, amateurs and professionals, and in the body politic we must accept them and make the best we can of their labors.

The Agricultural Department prepares hundreds of papers on the results of various experiments in the propagation of plants, flowers and fruits; the preparation of soils; the destruction of insect pests. It furnishes a digest of useful information, the perusal of which saves the farmer from making mistakes that his predecessors did and gives valuable suggestions by which he can improve on their efforts. All of these are given out without cost. Let the Interior Department make digests of the *various subclasses of patents* and print them in pamphlet form, issue them to manufacturers and patentees at cost, and there will not be so many conflicting patents issued.

The Agricultural Department employs skilled men to study soils, propagate new plants and improve old ones. Let the Interior Department do as much for inventors by holding friendly interference suits to determine validity or priority of patents. At the present time such a suit on the subject of "aviation" would be of immense value to the public at large and incidentally to both manufacturers and patentees.

Patentees are entitled to shops and laboratories where they can develop ideas, that the department decides have patentable features, just as truly as young farmers are to the benefits of the various agricultural colleges maintained for their benefit. Give them a "square deal."

Washington, D. C. O. C. KNIPE.

Kind of Hardness Measured by the Sclerescope

In reply to Mr. Shore's criticism on page 505 will say that whether or not "I am one of the foremost elucidators of metallurgical subjects" or am "more closely connected with the laboratory or factory" or have spent more years in these than he has lived, is immaterial; the question at issue being, not these, but what the scleroscope measures. And as very large claims have been made for this instrument, those who are investigating steels are trying it out and endeavoring to arrive at some definite conclusion and thus make it useful in the metallurgical world.

The main point which I made in my former discussion on page 210, and which Mr. Shore takes exception to, was that hardness was not what he claimed it was. Thus we see that most authorities agree that hardness in materials is the property which enables them to resist compression, penetration, division and abrasion. To these might be added some others, as for instance the property which makes water hard. This, however, is foreign to the subject and, therefore, we will confine ourselves mainly to those that can be applied to metals. Of the four mentioned above, Mr. Shore has taken one and summed it up in these words "Hardness is the property in metals that is proportional to its power to resist penetration." This definition he has tried to make applicable to all kinds of hardness and it is on these grounds that I differed with him.

Mr. Daniell said some 25 years ago that hardness is a property which cannot be measured and this statement probably holds good today. But when we say certain kinds of hardness, then we can and have successfully measured them. The scleroscope is one of the instruments that measures a certain kind of hardness and this instrument can be made useful in the toolroom and workshop as well as in the laboratory. For instance in testing a milling cutter to see that all the teeth around its circumference have been given a uniform hardness; to test several pieces of one kind to see that they have all been given the same degree of hardness, etc. In order to make it useful, however, we must know the kind of hardness that it measures and the effect this hardness has on the work required of the pieces.

Professor Turner has said in the report of his investigations on this subject that "There are in metals various manifestations of hardness according to the form of stress to which the metal may be subjected. These include tensile hardness, cutting hardness, abrasion hardness, and elastic hardness, but doubtless other varieties could be added to this." That all of these vary with metals at various temperatures might also be some food for thought.

That cutting hardness is not measured by this instrument is shown by the fact that high-speed steel has a lower rating on the scleroscope scale than carbon tool steel, yet the high-speed steel has greater cutting qualities than the carbon steel. One piece of brass also showed a hardness of 17, while a piece of copper showed a hardness of 30, yet the brass would scratch the copper, but the copper would not scratch the brass.

Another kind of hardness which the scleroscope might not measure is shown by the fact that india rubber gives a rebound of 23 and mild steel gives about the same reading, yet it is a generally recognized fact that steel is harder than india rubber. A similar instance is that white pine gives a rebound of 40 and this is much greater than mild steel or gray cast iron. Hard woods give a much lower reading than this, some of them as low as 10; lignumvitæ giving hardly any rebound. These examples would tend to prove that it is the resiliency of steel that the scleroscope measured, as I said in my former discussion, or the combination of toughness and hardness. And toughness might be said to be the result of the cohesive force which binds the atoms of the metal together in the mass. As Professor Turner puts it, however, "It appears to test what may be termed the elastic hardness" and this might be considered, by some, a better term to use for the property measured.

For abrasive hardness there is not so

much call for a measuring tool, and for tensile and compression hardness we have machines that will give us the results desired. The scleroscope working in conjunction with these can be made a valuable instrument, but as said before we must know what kind of hardness it measures and then be able to apply this knowledge successfully.

When it is claimed, however, that the sclerescope will tell the carbon contents of steel; give the tensile strength; show what the elastic limit is, etc., etc., then it is looked on with suspicion and placed in the catagory of the cure-alls. Thus many of those that could get good results out of it for the kind of hardness it will measure and the many applications they could give these results, in the numerous uses to which metals are put, do not adopt it as one of the standard testing instruments.

New York. E. F. LAKE.

American versus English High-speed Steel

I have read several very interesting articles in the AMERICAN MACHINIST relative to high-speed steel, its treatment, its cutting capacity and its economical application on machine tools. All of this was very instructive and a source of information to those who desired to get results that would justify them in buying such high-priced steel as the high-speed.

The last article which has come to my notice was written by a high-speed steel manufacturer on page 1031, Part 1, Volume 32. This seems to be, in purpose, very much removed from that of previous writers, in that he does not impart information of any value, but rather a distinct hunch to the American high-speed steel manufacturer combined with the appeal to the patriotism of Americans that is so common among legislators when defeat is close at hand.

In this article he referred us to a certain reported test of English high-speed steel that was run on cast iron at 60 feet per minute with a cut 3/16 inch deep and 1/16 inch feed. The tool removed 3½ pounds of chips and ran only two minutes. There is, however, no mention of the degree of hardness of this cast iron nor of how long the best of the American high-speed steel tools, in the same test, lasted.

Anyone should know that in our American foundries we are daily making castings on which no known high-speed steel would run two minutes with the above mentioned speed, feed and cut. It is possible that if the tool had been run with a ⅜-inch cut instead of 3/16, and ¼-inch feed instead of 1/16 inch it would have run much longer, but this was a test and very naturally an effort was made to cut the casting to the disadvantage of all tools. Thus, why the cut was only 3/16 inch deep and the feed 1/16 inch was because they did not wish to get under what is known as the crust.

Our manufacturers want a high-speed steel that will cut scale and stand up, as the time has long passed when 5/8 inch of stock is left on castings for the convenience of machining; also less care is taken to make soft castings, as economy is practised even in foundries; especially so where high-speed steel is used in the machine shop that has had its ability to cut hard castings fully demonstrated.

I recently visited the shops of a very large manufacturing plant, not far from Chicago, and found there some 25 cast-iron gears, about 28 inches diameter with a 4-inch face. These gears had to be bored out, but the foreman informed me that he had tried all of them and it could not be done. On every casting I could see tool marks that proved this. I asked them to have one of the gears put in the machine, and with the master mechanic went to their tool department and obtained a piece of the new English high-speed steel to fit the tool holder used on that machine (⅝ inch square and 30 inches long). This was hardened and put in their lathe, with others looking on, and I machined one of the castings to their entire satisfaction, thus saving for this firm not only delay but also many tons of castings.

In another shop not very far from the former I enjoyed the pleasure of seeing a tool made from the newer English high-speed steel, 1¾ inches square by 16 inches long, run on a 14-foot mill taking the back cut on a steel casting weighing 57 tons. This tool ran from about 5 p.m. until 10.45 a.m. the following day without grinding, taking a cut at times 1 inch deep with ⅜ inch feed. The speed was fast enough to burn up on the other side of the machine several of the best tools they could find in the shop, and this included the best known American high-speed steels.

The claim that certain of the newer English high-speed steels will do from four to seven times more work than any of the standard high-speed steels means that under the same conditions, namely, the same speed, same feed and same cut, 20 pounds of this newer English steel will last as long as 80 pounds or more of the best high-speed steel formerly made when machining certain kinds of stock, especially the hard metals.

The truth of this claim is daily being demonstrated to the satisfaction of many of the largest manufacturers with a result that now the rate of speed is being raised, with corresponding feeds; for it is needless to say that a tool which will run four times longer than another tool without grinding, will also run at a higher speed.

These steels have been given a new name to avoid their being confused with the old steels, and I can see no just cause for criticism there, as all steelmakers do the same, for the interest of the consumer as well as themselves, as this avoids their being confused with the brands formerly made.

I expect that our American mills will ultimately get to making the same high-speed steel, and then probably another step in advance will be made, as the limit has not yet been reached.

Milwaukee, Wis. C. A. HOLDRIDGE.

Thread Rolling Dies

At page 169 appears an article on thread rolling, which is a criticism of an article of mine at page 403, Part 1. The article referred to is not in error, since I did not assume anything, but simply gave a rule which I know has worked in practice for years; that is, on screws under ¼ inch with V-threads.

I would remind Mr. Scribner that steel undergoing the rolling process cannot be figured on like water, which is practically always of the same density, for the metal which fills the top of the thread is not the same as the bottom. Of course, in the case of a U. S. thread, the metal may behave differently, since we have not the cutting and spreading action of the sharp points. Referring to Mr. Webster's article, at page 630, of the issue of October 31, 1907, I will quote as follows: "This formula, however, is based on theoretical considerations, and it is necessary to allow for the distortion of the metal, and to make corrections in each case as determined by experiment;" also, "so that the short rule that is sometimes used is to select stock having a diameter equal to that of a finished thread less the hight of thread."

In conclusion, allow me to ask Mr. Scribner what he means by "area of the volume" at page 170, and also to remind him that the section of a thread as ordinarily rolled by 60-degree dies is not 60 degrees except at right angles to the helix; hence the elaborate formula does not apply exactly, and if a thread were rolled as shown in the sketch, it would take too much of a formula to find the volume of the rings mentioned before to be of any practical value.

DANIEL F. MORIARTY.

South Meriden, Conn.

The production of forged iron and steel car and locomotive axles, shafting, anchors, armor plate, etc., by the rolling mills and steel works of the United States in 1908 amounted to 131,143 gross tons, of which about 13,646 tons were iron and about 117,497 tons were steel. In 1907 the production of forged products by rolling mills and steel works amounted to 380,805 tons, of which about 23,772 tons were iron and about 357,033 tons were steel, while in 1906 the production of forged products was 352,636 tons.

Trade Opportunities in China

By M. de Moreira

The now famous loan solicited by China to finance the Hankow-Sze-Chuen railroad and the stand taken by President Taft have made many business men study carefully the conditions of affairs in China and the possibilities there for American trade.

A Large Field Open

These opportunities do not lie in the railways only. On the contrary the field for the American manufacturers is very varied. The street-car system of Shangai, for instance, which was built by the English, is not very uptodate in either its construction or its rolling stock; the need of machinery is very much felt throughout the whole of the country; the coal mines of Yashien need good machinery, their engines and boilers being very old and not fit to use; dredging machinery and modern locks are also necessary in various canals, and machinery for the cultivation of rice would sell promptly. This last item is of great importance and the various kinds of machinery needed are numerous. Pumps, engines, small dredgers and machinery for dikes, etc., are an absolute necessity for a plantation of fair size and a thorough investigation of the needs and conditions would certainly repay any manufacturer who would undertake it.

Textile Machinery

Manufacturers of machinery for yarn mills stand also a very good chance to sell their products in China as the Kuan Yi spinning mill in Changtehfu is the only spinning mill in the five northern provinces. This mill has about twenty-five thousand spindles and cannot meet the demand of half the provinces. New mills are soon to be started in the same territory, offering, therefore, an opportunity to our American manufacturers to introduce their products.

China manufactures also great quantities of grass cloth, but the machinery used in its fabrication is nearly all hand-power. Many fabrics are also made from the ramie plant. A new company has just been formed to manufacture goods from ramie with the use of modern machinery. They will have to buy, therefore, decorticating, degumming, combing, carding, spinning, weaving and knitting machinery and it apparently rests with us that they are purchased in this country.

Glass, Porcelain and Cement

A large glass factory has been built in Peking with the intention of manufacturing window glass, which is largely used in China, and forms one of the principal imports from foreign countries. Adequate machinery will have to be used and British and German manufacturers are doing their utmost to secure the order. Poshan, which is famous the world over for its glass and porcelain industries, is also a good center for manufacturers of machinery, furnaces, etc. Cement manufacturing is also to be started in a great factory of Poshan; this being the beginning of cement manufacture in China.

Harbor Improvements and Water Works

Since China has decided to open new ports, the necessity has arisen for harbor machinery. The latest decision is to open Lienshanwan harbor, which is very well adapted for a commercial port, as Fox Island is free of ice all the year round. Another commercial port will be open at Tachihuan. The survey of this port has been made by the Chinese but no decision has been taken as to where the machinery will be purchased.

Another great improvement for China is the abandonment of the immemorial custom of obtaining water supply from rivers utilized as a means of drainage; in various parts of the empire waterworks are to be built on the plan of the one already constructed in Canton.

The Canton waterworks consist of three settling reservoirs of a capacity of 6,000,000 gallons each, six sand filters with a filtering capacity of 1,250,000 gallons per day, and a covered storage reservoir of 2,000,000 gallons capacity. The pumping machinery consists of four sets of centrifugal pumps each capable of pumping 2,500,000 gallons per day. These pumps are for pumping water from the river to the reservoirs, and from the reservoirs to the filters. The main plant for pumping into the water tower consists of three pairs of direct-acting triple expansion engines, each pair being capable of pumping 2,225,000 gallons in twenty-four hours. The tower is 115 feet in hight to the base of the tank, the latter having a capacity of 180,000 gallons, and fitted with separate inlet and outlet pipes with connection between the two pipes, and an automatic electrical water-level indicator. The aggregate length of piping when finished will be nearly sixty miles.

Other Machinery

As seen, the scope for business in China is very large and machinery of any kind, now that China has decided to become progressive, will find a ready market. Manufacturers of ditching and diking machines, steam and wind pumps, agricultural machinery, traction engines, rice hullers, sugar refinery and tobacco machinery, hemp-decorticating machines, ice-making machines, concrete mixers, marine engines, etc., ought to study carefully their chances for success and once having realized the enormous number of opportunities existing in that market study just as carefully the methods they are to employ in order to introduce their goods.

English and German Influence

The trade is a good deal in the hands of the English and the German houses backed heavily by home capital, the former having been in the market for years and being well known by the natives, while the latter, although newer, are most aggressive. Both are experienced, both have large capital from home stockholders; they follow the natural tendency of placing value only on goods produced in their home countries, and have, moreover, close affiliations with many native houses due to English and German capital invested and they are very influential. It is a great mistake, therefore, for American manufacturers to make arrangements with English or German houses and give them exclusive agencies. Far from benefiting by such arrangements, the American manufacturer will be the loser as in the majority of cases these firms solicit the exclusive agency for American products in order to control their sales and prevent them from being pushed in the Chinese market.

The Department Store Plan a Mistake

Many manufacturers who have made English or German connections may think that this is purely imaginary, as their experience belies this statement. Nevertheless it is true and if they have been lucky not to suffer in their deals it is due to special conditions or to the article they manufacture by which they have practically no competition.

A great weakness in American trade methods in China is the custom of placing the business of a large number of agencies in the hands of one firm handling everything from sapolio to a locomotive. This department-store plan in agency arrangements is very detrimental to such products as machinery, which are not quick sellers, and the best suggestion to be made to manufacturers who cannot afford to have their own representatives on the ground is to pool together with manufacturers of kindred lines and establish an agency which will represent their lines only. In this fashion they will develop their business, control their sales and be in a stronger position to compete with foreign firms.

Banking and Credit

The question of banking and credit information is somewhat easy as Chinese banks have agencies in New York and English banks have been established in some parts of China for several years. Business information is not always easily obtained but, though prudence is a necessary virtue in commercial life, the Chinese merchants are, as a rule, conservative and reliable.

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September 9	19,250
September 16	19,250
September 23	19,250

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None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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A German Edition of the American Machinist

The establishment of the London edition of the AMERICAN MACHINIST was followed by an immediate increase in the circulation of the paper throughout Continental Europe and especially in Germany, where the circulation is now far in excess of that of any technical paper printed in the English language. Repeated suggestions have come to us that we establish an edition to be printed in Germany and in the German language and, after a thorough investigation of the field covering many months, this action has been decided upon. A corporation, the Hill Publishing Company (Germany), Ltd., has been organized, an editorial and translating force has been engaged and offices have been opened at 71 Unter den Linden, Berlin. The first issue will appear under date of January 1, 1910, and it will be a reproduction of the home issue for December 9, 1909.

Just as our English office has enabled us to keep our readers far more fully informed than heretofore of the progress of machine design and construction in Great Britain, so we expect our German office will be of equal assistance in a corresponding capacity in Germany. The three editions will make ours an international publication in a sense enjoyed by no other paper in existence. We do not doubt that our readers will share with us a pardonable pride in this evidence of our growing influence and that the enterprise will have their best wishes.

There is already a gratifying amount of interest in the enterprise in Germany and there seems to be no room for doubt that we will soon have a very satisfactory circulation in German speaking countries.

The German word *maschinist* means, literally, engine driver, and as this is not appropriate for a title, the word selected for that purpose is *Maschinenbau* which, translated, means Machine Construction, the entire heading, which is reproduced herewith in reduced facsimile, reading in English: German Edition of the AMERICAN MACHINIST. Journal of Machine Construction.

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THE HEADING OF OUR GERMAN EDITION

Great Days for the Machine Shop

Two things share today the center of the public stage, namely, aërial navigation and the discovery of the North Pole. In such circumstances it is perhaps invidious to mention the forthcoming Hudson-Fulton celebration of this city, but unless expectations founded upon the published program are overdone, the celebration is also to be an event of more than ordinary importance, while the events which it is to celebrate are worthy of association with any.

The discovery of the North Pole offers little material for comment in a publication such as ours, except that which is suitable for any publication—the regret that all American citizens must feel over the unseemly wrangle that is now in progress in the public press.

The other events, however, relate to triumphs of machinery and the machine shop. Last week we had the privilege of publishing illustrations of the machinery of Fulton's "Clermont," and elsewhere in this issue, will be found particulars of the aviation week at Rheims, which can scarcely fail to attract more than the usual amount of attention, especially as it contains the first published description of the Farman aëroplane with which the distance contest was won, and it seems to us that at the present stage of progress the length of flight is a far better gage of that progress than the extreme speed attained over a much shorter course.

The length of Mr. Farman's flight is, in fact, today the milestone of progress which was established at Rheims, and how far in advance of previous milestones it is, perhaps, best shown by the fact that the minimum distance which was established as the one which must be exceeded in order that the prize be won at all was less than one-third of that actually covered by Mr. Farman.

How great an achievement this is may be further appreciated from the fact that the time of flight is equal to that of maximum express-train runs, while the distance is two or three times as long as average express-train runs between station stops.

Along with this as a measure of progress must go the weather conditions under which practically all of the flights were made—conditions which as regards wind have until recently been absolutely prohibitive, and the fact that under such conditions the entire week passed without accident of a serious nature must satisfy the most skeptical that the day of aërial navigation is at hand.

We greatly doubt if even the most sanguine of those concerned with the inauguration and management of the week at Rheims could have expected such a series of strikingly successful events. In laying plans for the exhibition they builded better than they knew, the progress made in each case being naturally held a secret by each inventor and very likely the possibilities of his own machine being more or less unknown to himself.

Y. M. C. A. Aeronautic School

The West Side branch of the Young Men's Christian Association, which has conducted an automobile school with conspicuous success, announces that on October 13 next it will open an evening course of instruction in aëronautics under the direction of Wilbur R. Kimball. The movement is the outgrowth of a series of experimental lectures on the subject delivered last spring which developed a degree of interest sufficient, in the opinion of the manager of the association, to justify the inauguration of a more serious course of instruction.

The aim of the work is to prepare owners and prospective owners of aëroplanes for participation in and enjoyment of aërial sport; to train aëro chauffeurs and mechanics in the principles of aëroplane management; to teach practical men the principles of construction; to aid civil and mechanical engineers who wish to learn the applications of their science to flight and to prepare writers, newspaper men, advertising men and salesmen to specialize in the new field.

At the beginning no attempt will be made to give students actual flying practice, but it is expected there will be ample work in flying models and constructing miniature planes, the athletic field adjoining the association building providing an excellent model aërodrome for experimental work.

New Publications

THE IRON TRADE REVIEW. Daily Edition. Four 9x12-inch pages. The Penton Publishing Company, Cleveland, Ohio. Price, $10; or, in combination with the *Weekly Iron Trade Review*, $10 per annum.

There could be no better illustration of the magnitude of the iron and steel industry than the appearance of this little daily which, in accordance with the leading editorial of its first issue, is intended to meet a demand which exists for "spot news not less than for spot pig iron—to fill immediate requirements."

The new publication has our best wishes for its immediate and continued success.

MACHINE SHOP DRAWINGS. By Fred H. Colvin. Cloth; 139 4½x6¾-inch pages; 91 illustrations and numerous tables. Indexed. McGraw-Hill Book Company, New York. Price, $1.

In size and style this volume is uniform with the same author's books on "Machine Shop Calculations" and "Engine Lathe Work." It is intended to be a help to those who do not thoroughly understand the reading of drawings, rather than an attempt to teach drawing itself. To quote from the preface: "It shows how seen and unseen portions are represented, the use of full and dotted lines, the way in which different views are drawn, and how to study them all so as to secure the correct idea of the shape of piece represented. Many actual examples are given from the drawing-room practice of the leading shops in this country and the meaning of each carefully explained." The book is divided into the following chapters: Reading Drawings. Drawings of a Monkey Wrench. Some Examples of Drawings. Hints on Laying Out. Laying Out Spur Gears. Laying Out Bevel Gears. The Worm and Worm Wheel. Sketches—Rough and Otherwise. Under Chapter 1 the reader will find explained why two views are sufficient for showing certain kinds of work, while in other cases three or more views are necessary. In connection with third-angle projection, which is commonly used in this country, the author explains the arrangement of the various views in this projection and shows by sketches just how the different surfaces of an object are placed in correct relation to one another in plan and elevation. The same chapter illustrates the use of shade lines and gives a few common examples from shop practice in drawings of lathe centers, drill sockets, square and hexagon nuts, bolts, etc. A variety of drawings are included under Chapter 3, such as details of a bench-lathe head, head of a large lathe, general drawing of a locomotive, details of a grinder spindle, principles of a boiler setting, details of back rest for ratchet drills, longitudinal and cross-sections of a locomotive cylinder, complete drawings of an eccentric and eccentric strap, a special chuck screw, and details of a special flange. In order to show that drawings form a universal language a French drawing of a worm gear and worm is shown in this chapter. Chapter 4, "Hints on laying out," shows what can be done with scale, dividers, scriber, etc., in locating equi-distant points about a circle, as in spacing for bolt holes, laying out figures with various numbers of sides, laying out sheet-metal work for different purposes. This chapter also takes up the laying out of screw threads with the several conventional methods of showing such threads. A table is included in this chapter giving the chords for finding degrees of arc at 1 inch radius. Chapters 5, 6 and 7, dealing, respectively, with the laying out of spur gears, laying out of bevel gears, and the worm and worm wheel, will be found especially useful and interesting. Methods of laying out blanks and teeth are explained, and tables of standard and stubtooth dimensions are included as well as tables for sizing and cutting spur gears, general gearing rules, methods of figuring bevel gears, and worm gear and worm parts. The concluding chapter shows how useful shop sketches may be, no matter how simple and crude in appearance, so long as they are properly dimensioned. Useful hints are here given for the mechanic who desires to make sketches, and several examples are shown in isometric projection and in perspective. The chapter concludes with a few words on the handling of drawing tools and a group of cross-sections representing various materials.

Personals*

W. S. Chase, sales manager of the National Acme Manufacturing Company, of Cleveland, Ohio, sailed for Europe September 11, on a two months' business trip. Mrs. Chase accompanies him.

C. V. Raper, formerly tool superintendent, and more recently chief inspector at the Havre works of the Société Anonyme Westinghouse, has been appointed process engineer of that company.

Curtis C. Myers, mechanical engineer of the Diamond Chain and Manufacturing Company, of Indianapolis, Ind., has resigned to accept the position of shop coördinator in the coöperative engineering courses at the University of Cincinnati.

C. F. Perry, principal of the Milwaukee Trades School, has decided to remain in that position for at least three more years. Mr. Perry had been offered a place on the faculty of Columbia University, but consideration of home ties caused him to remain in Milwaukee.

Prof. Morgan Brooks, of the department of electrical engineering, University of Illinois, who is absent from the university during the present school year on leave, sails from San Francisco on October 12, on a trip which ultimately will take him around the world.

F. C. Brady, for eight years assistant chief inspector of the Chicago plant of the Western Electric Company, and more recently chief draftsman of the apparatus drafting department, has accepted the position of chief inspector with the Automatic Electric Company, Chicago, Ill. Mr. Brady will have charge of the design and manufacture of tools and gages in addition to the inspection department.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

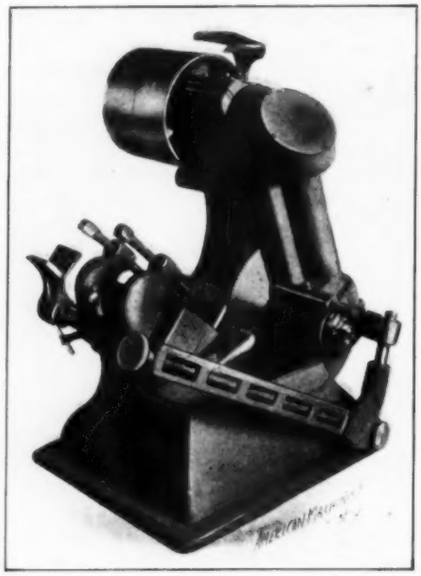
THE LATEST INFORMATION

A Bench Cutting-off Saw

The Taylor-Shantz Company, Rochester, N. Y., has just brought out a metal sawing machine, designed to go on a bench or stand, and to take the place of power hacksaws on all work usually within their range, or rather work on which they are generally used.

It is designed especially for tool rooms, electrical shops, and on account of using a very thin blade (3/64 inch only on small work) it is very economical in cutting up high-speed steel, or other expensive material. On larger work it uses a saw 5/64 inch thick, both being made of a semi-high-speed steel and having a specially shaped tooth, so that it can cut unannealed tool steel or copper with almost equal facility.

It is strongly designed and built, all wearing parts being large and durable. It is driven through accurately cut bevel gears to a large worm, all being hardened to insure long life. The vise is of the V-block pattern, accurately machined and with an adjustable clamping screw which allows the work to be clamped at any point in the vise. The saw runs in an oil bath and has a capacity of cutting off a 1-inch square bar per minute. The



BENCH CUTTING-OFF SAW

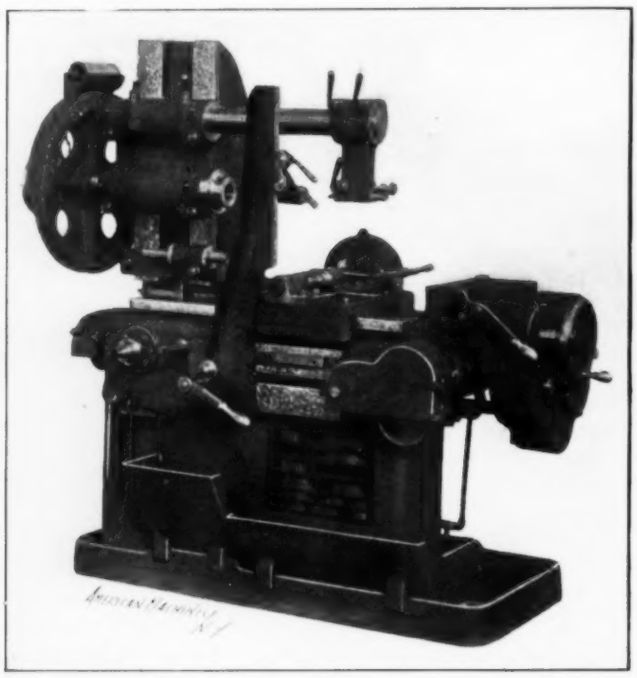
feed is secured by an adjustable weight on the hand lever, which makes it self-feeding when desired. There is an adjustable gage for duplicating different lengths of stock, and the work is cut off smooth and square, which is often more of an item than might be imagined. It weighs 160 pounds, and occupies a space of 14 inches square on the bench. It will cut off 4½x1, 4x2, 2¾ round or 2½-inch square stock.

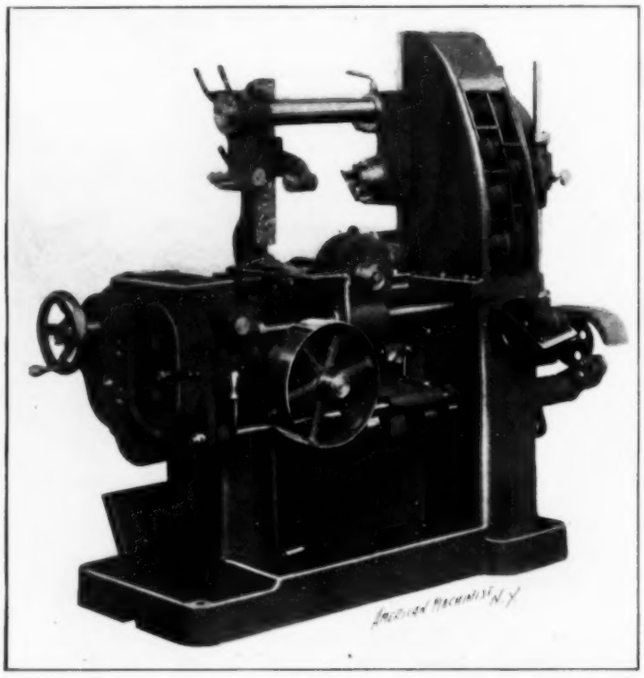
"Cincinnati" Automatic Gear Cutting Machine

The illustrations show a gear-cutting machine, which is made in two sizes, for cutting spur gears 26x10 and 36x10 inches, respectively. The power is transmitted through a single pulley, the various speeds and feeds being obtained through transposing conveniently located gears. The movements are all automatic, each being dependent on the preceding one, and cannot take place out of sequence. All shafts and spindles are accurately ground, and are journaled in bronze bushes.

The work saddle is so gibbed to the housing that the work arbor and blank do not drop out of parallelism when the clamps are loosened, for adjusting the work for the tooth depth. The screw is operated from the front of the machine, and has a micrometer collar graduated to 0.001 inch. The arbor is drawn in and forced out by a threaded shaft and handwheel.

The cutter slide has rectangular guiding surfaces with long taper gibs for taking up wear, both vertically and horizontally.





FRONT AND REAR VIEWS OF CINCINNATI GEAR CUTTER

The guiding surface is very long in proportion to its width to reduce binding action. The dogs, for adjusting the length of feed of cutter slide, are operated by a crank wrench from the front of the bed. A retractable tappet, for the adjustable dogs, is provided so that the slide can be run to the extreme back position for removing blanks, without disturbing the setting of the dogs. An automatic disengaging crank wheel is provided to move the slide by hand. The cutter slide returns at a constant speed, regardless of the rate of feed, which has 12 changes.

The cutter spindle, of large diameter, is accurately ground, has both a taper and a straight bearing, and is journaled in a bronze bearing that is adjustable endwise for centering the cutter.

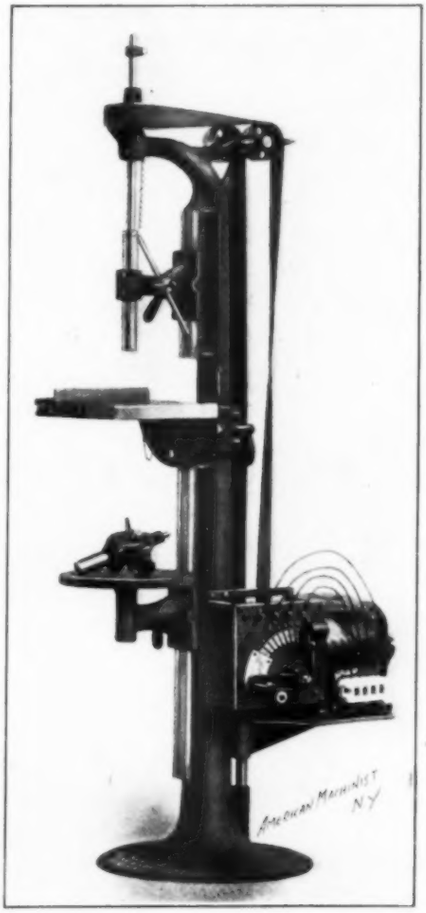
The drive is through a worm and wheel, with means for taking up end-thrust wear of worm. The cutter end of spindle is provided with a taper hole for receiving the cutter arbor; this arbor is keyed in the spindle and is drawn in and forced out by a threaded bolt. A removable bearing is provided for supporting the outer end of the cutter arbor. Six changes of speed are provided for the cutter spindle.

The indexing mechanism is of extremely simple construction, with remarkably few gears in the index train. The index worm can be disengaged from the wheel quickly and brought back into the exact meshing depth, or the worm can be disengaged from the index gears and rotated any desired amount for resetting work, and again secured to the index gears. The indexing mechanism is so interlocked with the cutter slide feed that it is impossible for the cutter to advance until the work is properly indexed, or when the cutter is feeding to index, thus making it impossible to spoil work. The work spindle can be made to space once or revolve continuously by a hand movement, under control of the operator.

The friction operating the disk stop is simple and accessible, as it is not necessary to dismantle any part of the machine to adjust it. Index change gears are furnished to cut all teeth from 12 to 100, and, with the exception of prime numbers and their multiples, from 100 to 450. Both overhead and outer supports for the work arbor, and rim support for the gear blanks, are furnished. They are built by the Cincinnati Gear Cutting Machine Company, Cincinnati, Ohio.

Motor Driven Sensitive Drill Press

This machine is self-contained in every particular, having the motor and starting box mounted at the back of the column. It will drill to the center of a 14-inch circle and has 5½-inch spindle travel, in connection with a 9-inch vertical adjustment of the head. This gives a maximum distance of 41 inches from the end of the spindle to the round table shown below, the square table being swung out of the way when desired. This square table has an adjustable bracket which prevents work being revolved by the action of the drill, and also acts as a guide in holding work to the drill.



MOTOR-DRIVEN SENSITIVE DRILL

A combination center, centering cut and centering force, is shown on the lower table and fits in the lower supporting arm when the round table is removed. Special care has been taken to provide a collar for taking up of any wear which would allow end movement to the spindle in its sleeve, this being particularly objectionable on small sensitive drills. The driving cone has an adjustment of 3 inches, so that an endless belt can be used and all necessity of cutting and lacing is avoided. This is known as the No. 5 machine of the Rockford Machine and Shuttle Company, Rockford, Ill.

An Automatic Two-Jawed Chuck

The illustrations show a two jawed box chuck for use on screw-machine work for lathes having a hollow spindle. The style shown in Fig. 1 has several advantages while for lathes to which this cannot be applied, Fig. 2 shows the simplest form to be used in such a case. A third form is also provided which differs only in placing the controlling lever at the back end of the tailstock and connecting it by a rod, instead of operating it from the front.

This is designed to take the place of an air chuck, obviating the necessity for the compressed-air system, and putting the lathe on an equal footing with a screw machine as usually fitted with an automatic chuck for rod work.

This will use jaws the same way as any two-jawed chuck, and they can be formed as shown in the illustration, or plain V-jaws for rod work. This has the advantage over the usual two-jawed screw chuck with the screw on one side, of hav

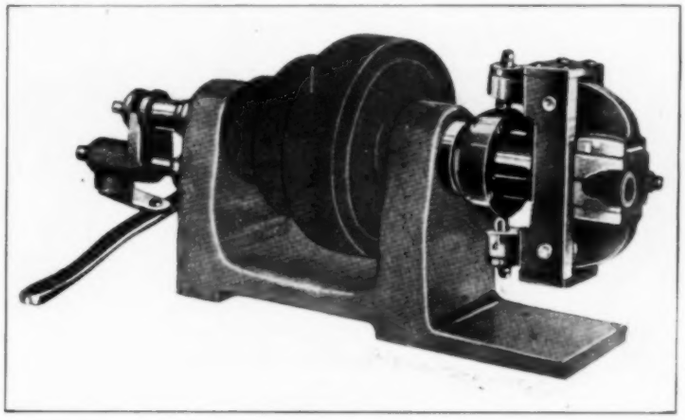


FIG. 1. AUTOMATIC TWO-JAWED CHUCK

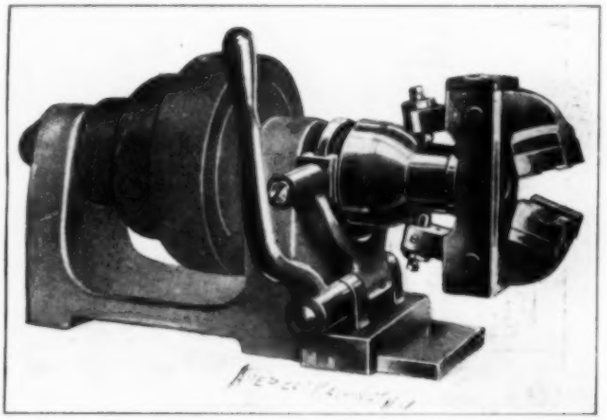


FIG. 2. OPERATED FROM THE FRONT

ing all the strain in a direct line, which insures longer life and better balance.

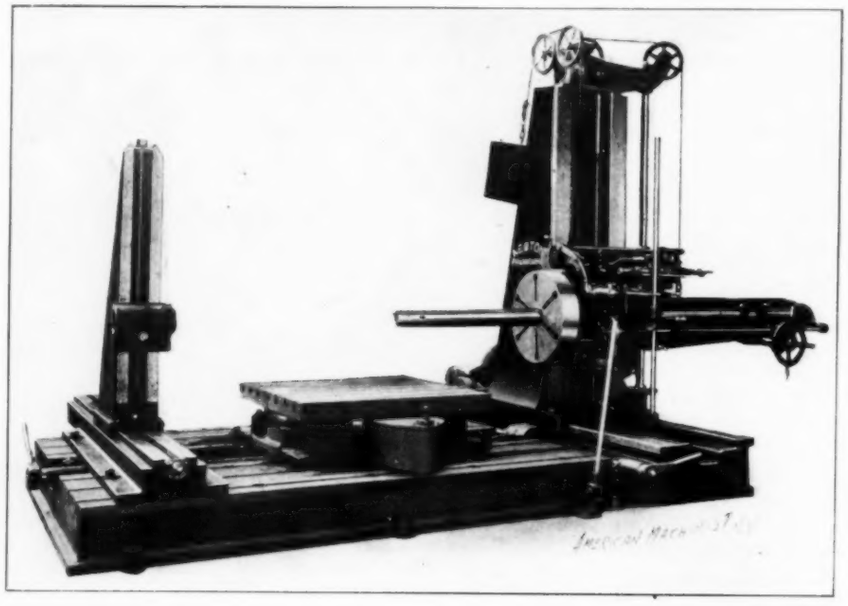
It is made suitable for lathes from 10 inches swing up and will hold work up to 3 inches in diameter, although larger sizes can be made. The special feature of this chuck is the cushion plunger which is placed on the rear of the operating jaw. This is adjusted for the work in hand, and after being properly set for the first piece, the plunger will automatically adjust itself to any variation in the pieces not more than 1/16 inch. This also prevents any crushing or injury to the walls of a casting, even if very thin.

As can be seen, it is not likely to be affected by chips, and the wide opening of the jaws will drop almost any piece without being touched by the operator, so that he is free to have a new piece ready for insertion as soon as the jaws open. This is built by the Cleveland Chuck Company, Cleveland, Ohio.

Horizontal Boring, Drilling and Milling Machine

The spindle of this machine is driven through intermediate gearing by a 10-horsepower variable-speed motor. The drive to the spindle is taken through a train of clutched bevel gears, giving a reverse to the direction of the spindle rotation. There is reversing fast traverse to the upright on the base for the saddle on the upright as well as reversing feeds with six changes ranging from 0.005 to 0.038 inch per revolution of the spindle with the high-speed gear in mesh, and from 0.0178 to 0.0124 inch per revolution with the faceplate gear in mesh. The spindle is arranged to drive the cutters by means of a broad face key and is provided with a No. 6 Morse taper. The diameter of the spindle is 5 inches; the length of the spindle feed with single grip 48 inches, and with double grip 90 inches. The vertical travel of the spindle saddle on the upright is 60 inches; the horizontal movement of the upright on the base 96 inches.

All levers controlling the different feeds, their rate and the different movements, are located on the front of the saddle within convenient reach of the operator. As shown, the outboard bearing of this machine is mounted on an auxiliary base, permitting of hand adjustment across the entire width of the bed. This auxiliary slide has a central bearing on the bed, adjustments being made by means of a bronze taper shoe. There is also furnished a rotating work table 48 inches in diameter, the circular adjustment being controlled by hand. There is provided a separate motor for feeding or rapidly adjusting this rotating table in a direction parallel with the travel of the spindle. This machine is built by the Newton Machine Tool Works, Inc., Philadelphia, Penn.



HORIZONTAL BORING, DRILLING AND MILLING MACHINE

Automatic Screw Machine

This machine is designed for making small parts such as screws, binder posts, nipples, etc., and in place of a turret car-

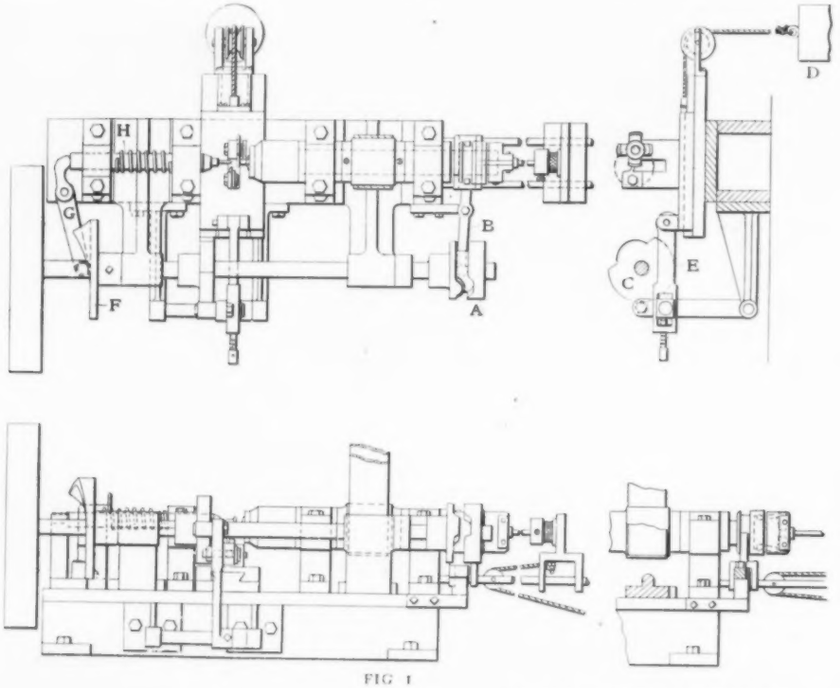


FIG. 1

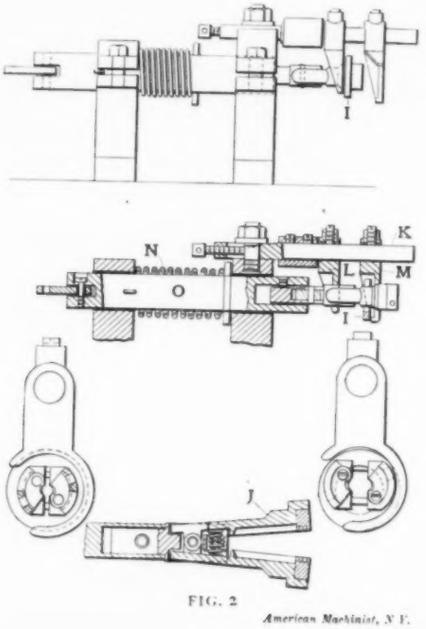
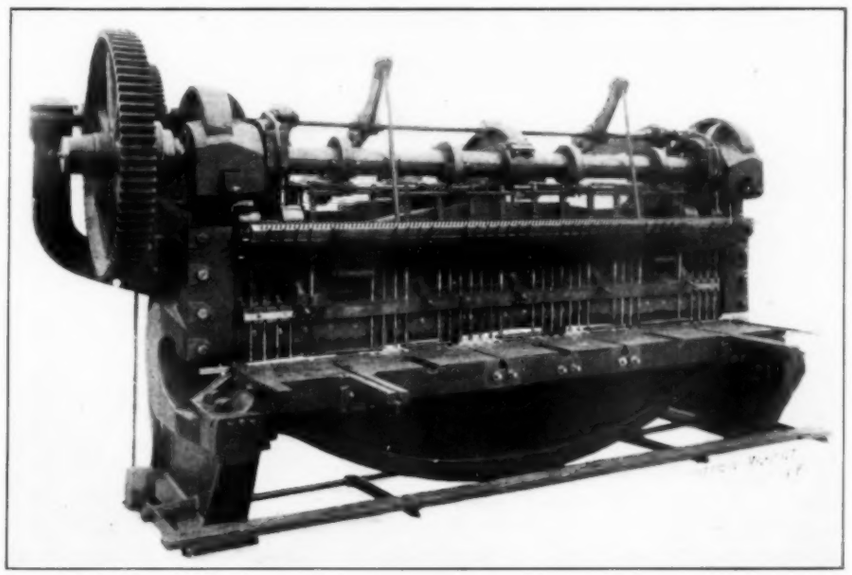


FIG. 2

American Machinist, N.Y.

AUTOMATIC SCREW MACHINE

ries a sliding spindle for holding a drill or other tool. As will be noticed, the machine is of simple construction, both spindle and cam shafts being driven by single pulleys. The spring-chuck mechanism is operated by cam *A* and lever *B*, the stock feed being actuated by a weighted cord attached to a bracket which feeds the bar forward when the chuck is opened. The cross-slide carrying the forming and cut-off tools is operated by cam *C* and weight *D*. The position of the slide with the tools may be adjusted by the screw at the rear of the connecting link *E*. Cam *F* and the lever *G* operate the sliding spindle *H*. When external threading is to be done, this spindle can be removed and the opening die mechanism shown in Fig. 2 substituted. This die consists of a pair of chasers carried at the front end of two pivoted jaws which are thrown open by a spring when not held together by the operating ring *I*, which acts upon the sloping shoulders of the jaws at *J*. When the spindle carrying this die head is mounted in place of the drill spindle *H* a stop bar *K* with two adjustable stops carried above the spindle bracket serves to open and close the die when the ring *I* comes in contact with these stops, *L* and *M*; that is, as the die runs forward on the work and cuts the thread to the desired length, ring *I* comes in contact with stop *M* and the pressure of the spring *N* still forcing spindle *O* forward forces the ring from the bevel shoulders of the jaws allowing



COMBINED SHEAR AND MULTIPLE PUNCH

them to open, when the die can be withdrawn from the work. As the die spindle is drawn back, ring *I* comes in contact with stop *L* and again closes the die ready for threading the next piece. The die chasers are readily removed when it is desired to change for another diameter of thread. The machine is made by L. Wollstein & Co., 16 John street, New York City.

Combined Shear and Multiple Punch

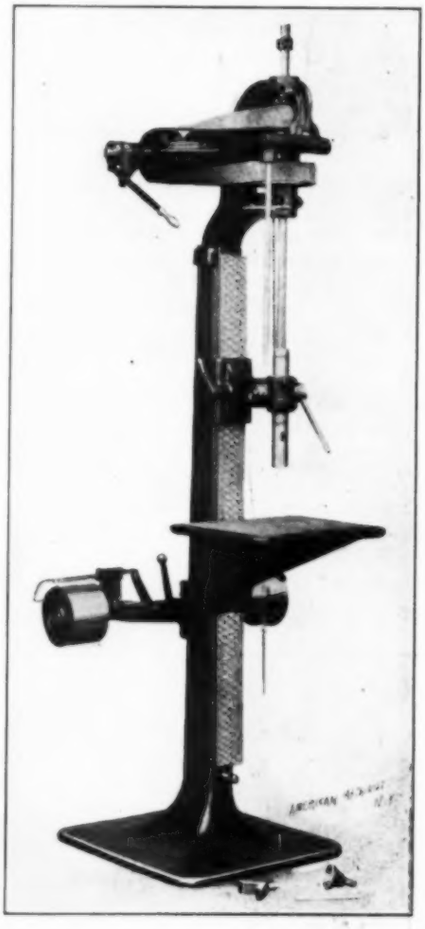
The illustration shows a combined shear and multiple punch, with 146-inch shearing blades and 144 punches, which can be used in any combination desired. As shown, the punch crosshead has been disengaged, so that the machine becomes a regular gap shear, with the holding-down rods in position to clamp the work securely. These rods are actuated by a bar at the back of the punch crosshead, and for some kinds of work a solid bar running the full length of the machine is fastened to the end of these rods.

The punch crosshead is counterbalanced, so that it can be easily handled in raising or lowering, and it is fastened in place by five studs, by which it is bolted solidly to the shearing crosshead. These machines are built in various sizes from 3 feet up to the one shown, which handles ½-inch plates. They are built for either belt or motor drives, and the machine shown weighs about 50,000 pounds. It is made by Bertsch & Co., Cambridge City, Indiana.

Kern Drilling and Tapping Machine

This is a friction-driven machine which can be used for either drilling or tapping, and will handle work up to the center of a 15-inch circle. Six spindle speeds are provided by three-step cones and a clutch on the back shaft which gives the other three speeds. The spindle is driven by a continuous belt, the reversal being controlled by the long lever coming down beside the spindle. There is an adjustment of the pulley-shaft frame so that a uniform tension can be secured at all times.

Both the head and table are adjustable vertically on the column, the head having a movement of 15 inches, which gives a maximum distance between the spindle and the table in its lowest position of 41 inches. The spindle's traverse is 5½ inches. This is counterbalanced and has an adjustable handle for the rapid approach and return of the drill. The table is square, has an oil groove and is provided with a cup center and a feed block. The frictions are at all times under control of the operator, and ball-thrust bearings are provided for the spindle in both directions. This is manufactured by the Kern Machine Tool Company, Cincinnati, Ohio.



KERN DRILLING AND TAPPING MACHINE

Adjustable Work Clamp

This is a very simple and convenient tool for holding work on a drilling machine, or other table, as can be readily seen from the illustration. It can be used either singly or in any combination desired and in any position. The clamping jaw is adjusted to the desired hight and held in position by the notches on the upright, while the whole thing is drawn down toward the work by the through bolt and nut in the T-slot of the ma-

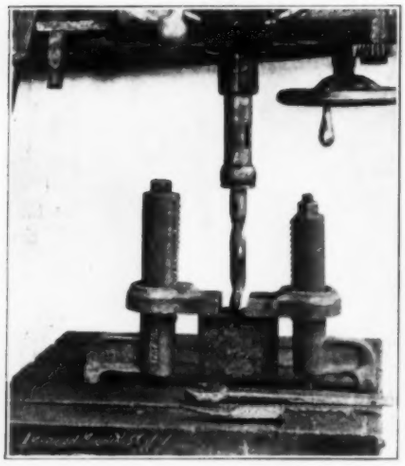


FIG. 1. USING CLAMPS IN PAIRS

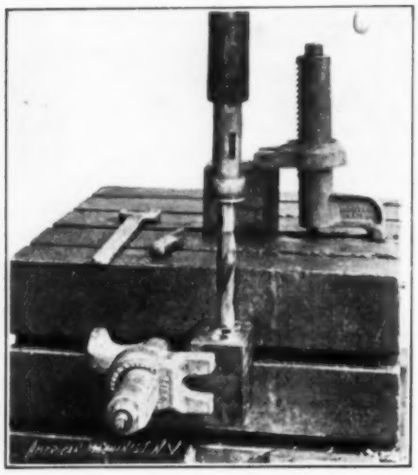


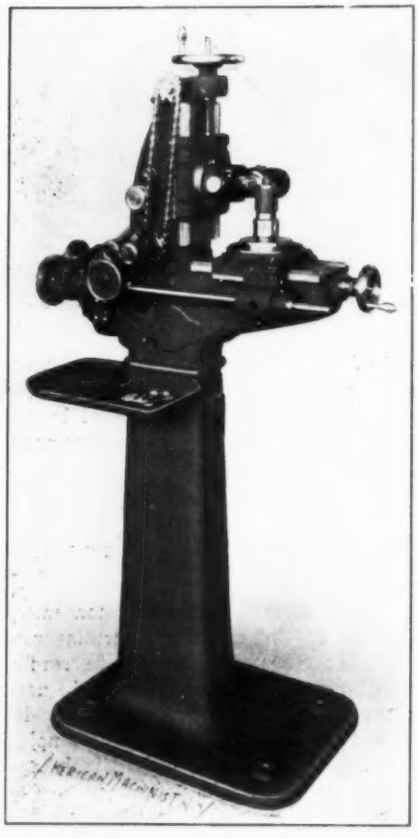
FIG. 2. SINGLY IN DIFFERENT POSITIONS

chine table. Every mechanic will appreciate its usefulness. It is manufactured by Howell & Murray, Waverly, N. Y.

A Very Small Gear Hobber

The machine shown, which we believe is the smallest gear hobber, has just been brought out by Schuchardt & Schütte, 90 West street, New York, and is known as their No. 000. This is in response to a demand for a machine to cut very small gears, such as for water meters, time clocks and similar work. It will hob gears up to 24 diametral pitch, 4 inches outside diameter and 6 inches face, and is capable of very rapid work, the cutter spindle running 600 revolutions per minute.

It is entirely automatic, as with their larger machine, but is arranged so that hand feed can be used when desired in cutting small worm gears. The design and construction of this machine is very similar to the larger machine of this type, the gear guard being removed for photographing. It is already finding a large field of usefulness in gear cutting of the smaller sizes.



A SMALL GEAR HOBBER

Fulton Exhibit, Engineering Societies Building

The Hudson-Fulton celebration is essentially a recognition of the explorer and the engineer. To show the relation of the latter to the celebration, models of the Clermont and other early steamboats, through the courtesy of the Smithsonian Institution, are now on exhibition at the rooms of the American Society of Mechanical Engineers in the Engineering Societies building, 29 West Thirty-ninth street. The exhibit includes the "Clermont," the "Phœnix," built by John Stevens, and one of John Fitch's early types. Original drawings by Fulton, an oil portrait of Fulton painted by himself, Fulton's dining table, oil portraits and bronze bust of John Ericsson, models of the "Monitor," all owned by the society, and Ericsson's personal exhibit at the Centennial exposition, are also exhibited. Through the courtesy of the Hamburg-American line, a beautiful model of the "Deutschland" shows the highest type of the development of steam navigation.

The model of the "Clermont" represents the vessel as she was on her maiden trip. It differs in some respects from the "Clermont" as built for the Hudson-Fulton celebration as the original boat underwent repairs after her first trip to fit her for regular passenger service. The original data are somewhat at variance as to the dimensions of the vessel and the design of the engine. The dimensions of the model were taken from a letter written by Fulton to James Watt, the length of the boat being given as 175 feet, the width 12 feet and the depth 8 feet. After making four trips the length was reduced to 150 feet and the width increased to 18 feet. These are the dimensions of the new "Clermont." The engine of the model also differs from that of the new "Clermont" in that the engine of the model has but one flywheel, which is placed on the same shaft and between the two paddle wheels, while the new vessel has a flywheel outside the hull on both sides.

On returning from the first trip the "Clermont" underwent some improvements to better fit her for regular passenger traffic. At the end of this time the following rates to various points from New York were advertised: Newburgh, $3, 14 hours; Poughkeepsie, $4, 17 hours; Esopus, $4.50, 20 hours; Hudson, $5, 30 hours; Albany, $7, 36 hours. In Renwick's "Life of Fulton," in addition to the foregoing rates, the following details are given:

All other way passengers to pay $1 for 20 miles passage and half a dollar for each meal.

Children between 1 and 5 years, one-third price if sleeping with those having charge of them.

Young persons between 5 and 13 years half price sleeping two in a berth; full price sleeping one in a berth.

Servants, two-thirds price for one in a berth; one-half price for two in a berth.

Each passenger paying full price was allowed 60 pounds of baggage; if less than full price, 40 pounds of baggage. For surplus baggage 3 cents a pound was charged.

In the meantime John Stevens was engaged in building his steamboat, "Phœnix," which was launched on April 9, 1808, at Hoboken. Stevens began his work in steam navigation in 1791. In 1798, a steam-propelled vessel was tried on the Passaic river. The New York legislature was petitioned by Stevens for a monopoly of steam navigation, but the petition was not granted.

In 1804 a 68-foot boat 14 feet wide, fitted with a single-screw propeller, was built by Stevens and in 1805 a twin-screw boat was launched on the North river. The machinery of this boat was afterward placed in a larger boat, the "Phœnix," 103 feet 3 inches long, 16 feet wide and 6 feet 9 inches deep.

In the spring of 1809 the "Phœnix" made a number of trips between New York and New Brunswick, a distance of 37 miles in 9½ hours, including stops, but perhaps owing to the fact that the nearly completed "Rariton," Fulton's second boat, was intended for operation over this course it was decided to sail the "Phœnix"

to the Delaware river by way of the Atlantic. She left New York on June 8, 1809, arriving at Philadelphia on June 17. Thus was accomplished the first sea voyage of a steam-propelled vessel.

The "Phœnix" ran as a passenger boat on the Delaware, stopping at Philadelphia, Bordentown and Trenton, where connection was made with stages across New Jersey to New Brunswick, one of the terminals of the "Rariton." After running for a number of years over this route the "Phœnix" was wrecked at Trenton in 1814.

The model of John Fitch's steamboat represents one built in Philadelphia in 1786, a successful public trial being made on the Delaware river on July 27 of that year. The length was 34 feet; width, 8 feet; depth, 3 feet 6 inches. It was equipped with a steam engine which, connected by geared machinery, sprocket wheel and chain, operated six oars placed vertically in a frame on each side of the boat.

In 1788 Fitch completed his first commercial boat for carrying passengers, and it was driven in a similar manner. This boat was 60 feet long and 8 feet wide. On July, 1788, a trip was made from Philadelphia to Burlington, about 20 miles, the longest ever made by any steamboat up to that date. In 1790 Fitch built another boat, which attained a speed of eight miles an hour, and continued to run on the Delaware river, carrying passengers and freight, for three or four months.

The exhibition will be open to the public every week day from 9 a.m. to 5 p.m.

Forthcoming Meetings

American Peat Society, third annual meeting, Massachusetts Institute of Technology, Boston, Mass., Sept. 23, 24 and 25. Julius Bordollo, secretary, Kingsbridge, N. Y.

National Machine Tool Builders' Association, fall meeting, October 12 and 13, New York City. P. E. Montanus, secretary, Springfield, Ohio.

National Society for the Promotion of Industrial Education, annual convention, December 1, 2 and 3, Milwaukee, Wis. J. C. Monaghan, secretary, 20 West Forty-fourth street, New York City.

Business Items

The fire which visited the Cincinnati plant of the S. Obermayer Company, on September 11, only damaged the warehouse and did not interrupt in any way the business or the filling of orders.

Garwood Electric Company, Garwood, N. J., reports taking a number of orders recently, among others, a slow-speed engine-type 150-kilowatt generator, 17 motors of various sizes for ventilating work, and a 250-kilowatt engine-type generator for export.

Gisholt Machine Company, of Madison, Wis., manufacturers of turret lathes, boring mills, tool grinders, etc., has recently opened an office in New York City, Hudson Terminal building, room 1253. The office is in charge of Ellis F. Muther, who will look after the Gisholt interests in the East. The eastern agency arrangement formerly in effect has been discontinued, the idea being to give to the business the closest attention of Gisholt specialists.

The Niagara Machine and Tool Works, Buffalo, N. Y., have purchased a plot of land of about seven acres adjoining the New York Central belt line where they expect to erect a group of modern buildings to carry on the manufacture of their line of machinery to better advantage than it could be done in their present plant. Their business has had a steady development during past years and the proposed greatly increased quarters is the result of an expanding domestic and foreign trade.

Business Opportunities

D. Finney, Wausau, Wis., will erect a varnish factory to cost $6000.

Fire destroyed the plant of the Hagerstown (Md.) Foundry Company.

The Olyphant (Penn.) Foundry Company will build an addition to its foundry.

The Milwaukee (Wis.) Drydock Company will build an additional machine shop.

The American Hide and Leather Company, Merrill, Wis., is building an addition.

The Stevens Box Factory, at Spring Hope, N. C., recently burned, is to be rebuilt.

The Detroit (Mich.) Wire Spring Company, will erect an addition to its plant.

The Milwaukee (Wis.) Reliance Boiler Works, will build an addition to its plant.

The Raser Furnace Company, Barberton, Ohio, has purchased site for a new plant.

The Fassett Planing Mill, Findlay, Ohio, recently destroyed by fire, will be rebuilt.

The Ideal Foundry Company, Grand Rapids, Mich., is building an addition to its plant.

The E Z Auto Go-Cart Company, Beloit, Wis., will remove its plant to Monroe, Wis.

The Allenhurst (N. J.) Light and Power Company, is to enlarge its pumping station.

The Owosso (Mich.) Corrugated Steel Culvert Company has purchased site for a plant.

Krasin Brothers, of Tigerton, Wis., will build a cold-storage plant at Marathon City, Wis.

The Atlantic Coast Electric Railway Company, Allenhurst, N. J., will enlarge its power plant.

The Mead Pulp and Paper Company, Chillicothe, Ohio, will double the capacity of its plant.

The Universal Machine Screw Company, Hartford, Conn., has bought site for a new plant.

Halloway & Falk, Sparta, Wis., will open a new steam laundry to replace one recently burned.

Jenks & Muir, Detroit, Mich., manufacturers of iron beds, are erecting a new factory.

The Defiance Wall Paper Company, Niagara Falls, N. Y., is having plans prepared for a new plant.

Wm. Lantor, of Loomis, Wis., will operate a lath mill in connection with his saw and shingle mill.

The Best Foundry Company, Bedford, Ohio, will erect an addition, doubling the capacity of its plant.

The Manitowoc (Wis.) Foundry and Machine Company will enlarge its machine shop and foundry.

The Franklin (Ohio) Wheel Company, a new concern, is building a plant. Will employ about 70 men.

It is said the Crawford Automobile Company will build an addition to its plant at Hagerstown, Md.

The Produce Dispatch Company is building a new creamery at Middlebury, Vt.; also one at Vergennes.

The Diercks Lumber Company, De Queen, Ark., is preparing to rebuild its mill burned a short time ago.

The plant of the Railway Steel Spring Company, Pittsburg, Penn., was destroyed by fire. Loss $60,000.

The Grand Crossing Tack Company, Chicago, Ill., is said to be planning the erection of another building.

The John T. Young Boiler Company, Norwich, Conn., has started work on the erection of a new plant.

The plant of the Sedro Woolley Iron Works, Sedro Woolley, Wash., was destroyed by fire. Loss, about $26,000.

Plans have been completed for a four-story addition to the plant of the Moline (Ill.) Automobile Company.

It is stated that the Ulster & Delaware Railroad Company will erect a new roundhouse at Oneonta, N. Y.

The Hill Storage and Implement Company, Burlington, Vt., is to put in new machines and operate repair shop.

The plant of the Fynnestededt Machine Company, Pittsburg, Penn., was destroyed by fire. Loss, about $50,000.

The Hord Rubber Company, East Watertown, Mass., has awarded contract for construction of a new building.

The plant of the Meteor Motor Car Company, Davenport, Iowa, was partly burned, causing a loss of about $40,000.

The Niagara Machine and Tool Works, Buffalo, N. Y., has purchased site on which a large new plant will be erected.

The A. E. Oliver Manufacturing Company, Buffalo, N. Y., builders of special machinery, will build an addition to its plant.

The Imperial Iron Company, Duluth, Minn., manufacturers of lumber and milling supplies, will build an addition to its plant.

Plans are being prepared for a two-story addition to the plant of the Atlas Brass Foundry Company, Columbus, Ohio.

The Chicago, Burlington & Quincy Railroad has awarded contract for the erection of a new roundhouse at Rock Falls, Ill.

Plans are being prepared for a one-story addition to the cable plant of the Western Electric Company, at Hawthorne, Ill.

The Broderick & Bascom Rope Company is planning the addition of another building at its plant in South Seattle, Wash.

The Ward Nail Company, Youngstown, Ohio, recently organized, is looking for a site for its plant. David Tod is president.

The Keek-Gonnerman Machine Company, Mt. Vernon, Ind., is erecting two additions to its plant, including an auto garage.

Plans have been prepared for a new roundhouse for the Union Railroad at Newcastle, Penn. General offices are in Pittsburg.

The Trumbull Electric Company, Plainville, Conn., will build two additions to its factory, one to be an annealing room.

The Scott Iron and Steel Company, Carnegie, Penn., is asking for estimates on two electric cranes of 15 and 25 tons capacity.

It is reported the Virginian Railway Company is to build shops at Princeton, W. Va. H. Fernstrom, Norfolk, Va., chief engineer.

The Dyer Company, of Cleveland, Ohio, will erect at Mercedes, Texas, a new town, a sugar mill which is to cost over $2,000,000.

The Wisconsin Auto Supply Company, Two

Rivers, Wis., will enlarge its plant, will build gasolene engines for automobile and farm use.

The Muskegon (Mich.) Extract Company is erecting a new plant for the manufacture of tanning fluid from by-products of paper mill.

The Standard Box Company, Baton Rouge, La., will erect an addition to its plant. Planing mill and box machinery is to cost $36,000.

The American Pressed Steel Rail Company, of Washington, Penn., is said to be contemplating establishing a branch in Hagerstown, Md.

The Patterson Mills Company, Roanoke Rapids, N. C., lately incorporated, has plans ready for building. Will manufacture ginghams.

The Bullard Machine Tool Company, Bridgeport, Conn., has awarded contract for the construction of a large addition to its plant.

Plans are being prepared for a new factory for the Cassady-Fairbanks Company, Chicago, Ill., for the manufacture of hardware specialties.

The Carbondale Machine Company, Simpson, Penn., expect to install in its power plant a 500-horsepower Corliss engine in the near future.

The International Steel and Iron Construction Company, Evansville, Ind., will erect a plant for the manufacture of steel and iron novelties, house and store furnishings.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E. G. Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—To purchase or manufacture on royalty, a small tool or similar device. Box 683, AMERICAN MACHINIST.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

First-rate German house wishes offers for vulcanized fiber. Answers to K. U. 8424, Rudolf Mosse, Cologne-on-Rhine, Germany.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Machinists and engineers blueprint chart of United States Standard pipes and tapping sizes from ⅛" to 10" pipe. Price 10 cents per copy postpaid. Liberal discounts to shop agents. Address Charles Kuderer, Woodlawn, Penn.

Automatic and special machines, dies, models designed, inventions developed, tool equipments planned, working drawings; prices reasonable; satisfaction assured. Address C. E. Buffington, M. E., 92 Market Street, Newark, N. J.

By manufacturer, agents or dealers to handle oil cup of improved design; excellent cup and can be sold at a low price; large field for the sale of this device among machine shops, mills, etc. For particulars address Box 612, AMERICAN MACHINIST.

Wanted—Heald, or Brown & Sharpe cylinder grinder in good condition; also a multiple spindle drill or multiple spindle drill head, Baush, or a Pratt & Whitney preferred, 8 to 15 spindles for drilling ⅜ holes in aluminum and capable of 19-inch circle; also 23-inch disk grinder; state condition and name best price. The Jewel Carriage Company, Cincinnati, Ohio.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Experienced stenographer, French, German, or English, having completed course of mechanical drawing, seeks situation, where he can gain practical experience in drafting. Box 691, AMERICAN MACHINIST.

ILLINOIS

Superintendent, efficient in uptodate machine shop and manufacturing methods; an expert in the design of tools for interchangeable work, cost reduction, etc; able to handle large works. Box 697, AMER. MACHINIST.

MARYLAND

Machine shop foreman, age 38, with twelve years' experience with modern methods, desires a change of present position; reliable, energetic and resourceful. Box 689, AM. M.

MASSACHUSETTS

Wanted—Position as assistant superintendent; American, energetic and systematic; technical training; practical and executive experience; designing ability; thoroughly familiar with modern manufacturing methods, pattern and foundry work; cost accounting, etc.; references. Box 690, AMER. MACH.

NEW JERSEY

Mechanical draftsman wishes position. Address Box 685, AMERICAN MACHINIST.

Superintendent, 42, now employed, technical, uptodate, a hustler, specialty fine tools or instruments, desires change; references. Box 680, AMERICAN MACHINIST.

Wanted—Position as assistant to superintendent. Present position chief draftsman gas and steam engines, pumps, condensers and general machinery. Best references. Box 696, AMERICAN MACHINIST.

Manager, now holding responsible position, wishes charge of medium size plant manufacturing typewriters, adding machines or a similar line; splendid training; best references. Box 681, AMERICAN MACHINIST.

NEW YORK

Intelligent, young machinist and toolmaker, for light, experimental machines. Box 686, AMERICAN MACHINIST.

Foreman, an all-round machinist and toolmaker, 20 years' experience; 10 years as a foreman. Box 695, AMERICAN MACHINIST.

Young man with broad experience desires position as office manager, accountant, exact, thorough, or will take position as traveling salesman; have been on the road two years. Box 684, AMERICAN MACHINIST.

Position wanted; A-1 designer of jigs, fixtures and dies in all their variety, seeks higher and more active position; seven years present employers; nine years' general shop experience; all answers considered. "American," Box 692, AMERICAN MACHINIST.

OHIO

Works manager or general superintendent invites correspondence from reliable concerns wishing to secure the services of a high-class executive with a clean-cut record as an earning power. Address Box 654, AMER. MACH.

Mechanical and electrical engineer, technical graduate, with 7 years' experience as engineer and designer, special crane, hoisting and conveying machinery, wants change of position; go anywhere. Box 693, AM. MACH.

Up-to-date mechanical engineer, expert mechanic, designer and shop man, with quick comprehension, 13 years' vast experience in sheet metal working and automatic machinery, tools, dies for cheap and rapid production, accustomed to heavy responsibilities, wants position. Box 663, AMER. MACHINIST.

Position as superintendent, assistant superintendent or general foreman; age 37; fifteen years' office and shop experience; in smith and machine shop, as chief draftsman and salesman and superintendent; good reference; member American Society of Mechanical Engineers; moderate salary acceptable. Box 676, AMERICAN MACHINIST.

PENNSYLVANIA

Valve patternmaker foreman wants position. Box 694, AMERICAN MACHINIST.

WISCONSIN

Man with 20 years' experience as superintendent and manager of large machine works is open for an engagement October 1. Applicant is fully qualified to assume entire charge of office and works as its official head. Have good executive ability, good organizer and can produce maximum amount of work at minimum cost. Box 666, AMER. MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—First-class toolmakers on punches and dies; steady work to competent men; wages 35 to 40 cents per hour. Apply to Canadian General Electric Co., Ltd., Peterboro, Ont.

CONNECTICUT

Wanted—A first-class toolmaker on jig and fixture work. Box 621, AMER. MACHINIST.

INDIANA

Two experienced foremen for machine and assembling rooms, manufacturing gasolene motors. Give reference, experience and age. Box 262, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—First-class draftsman. Supervisor of Drafting Rooms, General Electric Co., Pittsfield, Mass.

Wanted—Machinists; first-class men on engine and pump work as layout men, lathe hands, planer hands, drilling, boring, etc.; good pay and steady work; works near Boston. Address Dept. 52, P. O. Box 167, Boston, Mass.

Manufacturing company located in Boston offers exceptional opening for man capable of taking charge of shop and of producing results; an investment of about $10,000 is necessary and this will secure a controlling interest. Address John M. Kendricken, 53 State Street, Boston, Mass.

Wanted—Iron foundry foreman; man who can assume responsibility for quick deliveries of good castings; medium and heavy work, 35 tons daily; must be an organizer and thoroughly practical foundryman, and used to machines; Massachusetts plant building engines, valves, pumps, etc.; correspondence will be treated confidential. Address Dept. 51, P. O. Box 167, Boston, Mass.

Wanted—Thoroughly competent young man with some mechanical and executive experience to act as assistant superintendent in a small thoroughly equipped progressive factory manufacturing small tools, located in a large city in Western New England. Owing to certain conditions right man has an unusual opportunity for speedy advancement. In sending application state fully in detail all qualifications, for whom you have worked, present position, salary expected, etc. Box 638, AMERICAN MACHINIST.

Wanted—High-grade foreman to take charge of a manufacturing department operating lathes, milling machines and screw machines. Applicant must be a young man of good mechanical experience and ability, thoroughly familiar with all modern tools and methods, and capable of producing accurate work rapidly and economically; only men with first-class records occupying similar positions in charge of at least 100 men and looking for a permanent position will be considered; give full particulars regarding present position, past experience, and wages required; all correspondence considered strictly confidential. Box 675, AMER. MACHINIST.

MICHIGAN

Wanted—First-class, all-round machinists; good wages and steady employment for competent men. Apply to Michigan Machinery Mfg. Co., Ypsilanti, Mich.

Wanted—Man to take charge of tool crib; must thoroughly understand the most uptodate systems for keeping tools and checking; only applications from thoroughly first-class reliable men will be considered; give full particulars of experience, references, age and wages expected. Apply Buick Motor Co., Flint, Mich.

Wanted—By a large company, a man who is fully capable of designing A-1 tool equipments for turret lathes, such as Gisholts and similar machines, of which we have a large number. Applicant must be well posted on most effective methods of procuring results from turret lathes, and able to put his ideas to effective use; work will be steady and pay liberal to the right man; state qualifications fully. Box 625, AMERICAN MACHINIST.

NEW YORK

Wanted—Mechanical draftsmen, experienced

in electric traveling crane designing. Box 633, AMERICAN MACHINIST.

Wanted—Operator on Cleveland screw machines; state experience and wages expected. Otis Elevator Company, Yonkers, N. Y.

Wanted—Automatic screw machine operators, man with experience on Brown & Sharpe, Cleveland and Acme; central New York. Box 653, AMERICAN MACHINIST.

Wanted—A first-class machinist and cornet player; give machine shop and band experience; must be a man of good habits; references. Box 698, AMERICAN MACHINIST.

Wanted—General foreman for iron machine shop, one experienced in economical production of iron valves preferred; state salary expected, age and experience; also if now employed. Box 682, AMERICAN MACHINIST.

Lathe, planer and boring mill hands wanted for day and night shift; no labor troubles, increasing force; applicants must state wages desired, past experience, if employed at present, and the names of past employers, to receive further consideration. Application considered confidentially. Apply Ingersoll-Rand Co., Painted Post, N. Y.

Wanted—High-class factory superintendent to take charge of plant employing 750 hands; eight acres of floor space, 1800 machines; plant includes machine shop and tool room for manufacturing all tools and machinery in use; none but first-class men need apply; one with technical education preferred. Box 640, AMERICAN MACHINIST.

Wanted—First-class machinists and toolmakers; open shop, nine hours per day, six days per week; all new modern tools; no labor troubles; plenty of work on hand; clean, healthful, up-to-date city in which to live; highest wages paid to workmen who can demonstrate their ability to be rated as first-class machinists. Apply stating experience, references and wages required. Box 629, AMERICAN MACHINIST.

Wanted—A thoroughly practical and energetic mechanic to take a position as rate fixer on premium work in the shop, building high-speed engines; must be familiar with jigging work and fixtures; must have fair education, good at figures and systematic; must be able to go into machine shop and make demonstrations. Apply stating age, nationality and previous experience, also whether employed at present and by whom. Answers will be treated confidentially. Box 643, AMERICAN MACHINIST.

OHIO

Machinist. 201 Nicholas Bldg., Toledo, O.

Wanted—Manager, who can obtain some capital, for modern machine works, running day and night, located in Ohio. "Engineers," Box 678, AMERICAN MACHINIST.

Wanted—Experienced foreman for milling machine and gear-cutting department in shop manufacturing machine tools; reply, stating age, experience and wages desired. Address Box 667, AMERICAN MACHINIST.

Draftsman for high-grade machine-tool work; advanced position; large factory; applicant must be thoroughly capable in original designing; reply fully, giving experience in detail and state age and education. Box 670, AMERICAN MACHINIST.

Supervisor of labor for factory employing 500 men. Line, machine tools. Must be specially qualified to handle all matters pertaining to the employment and efficiency of labor. State age and education and give full particulars regarding experience, especially during the last five years. Box 671, AMER. MACH.

General foreman with executive ability and uptodate methods in general machine shop practice, to take charge of about 100 men; must have had 10 years' experience in handling men; give references, experience, wages and state date for personal interview at factory. The Foos Gas Engine Co., Springfield, O.

Wanted—General superintendent with wide experience and progressive methods in factory operation and production, by an office specialty manufacturing company; in writing, give age, experience, references and salary expected. All correspondence will be treated strictly confidentially. Box 687, AM. MACH.

Wanted — First-class machinists, lathe, planer, drill press, screw machine, boring and milling machine operators, die sinkers and patternmakers who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Building, Cleveland, O.

Superintendent: Progressive manufacturers having foundry, pattern and machine shops employing 500 men, need a thoroughly experienced and systematic superintendent; machine shop training essential; foundry experience preferred; give full details, past and present record, naming employers; communications strictly confidential; only men with a record need apply; location Ohio. Box 688, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—A good live agent in every shop or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Kienzola Co., Erie, Pa.

RHODE ISLAND

Foreman for bolt forging department of nut and bolt manufactory; must have had experience with Burdict headers and be familiar with the making of special bolts of all kinds; give references, age and salary expected. Box 646, AMERICAN MACHINIST.

WISCONSIN

Wanted—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 564, AMER. MACH.

For Sale

For Sale—Bound volumes AMERICAN MACHINIST for 1899, 1900, 1901, 1902. Also several later volumes, unbound. Box 684, AMERICAN MACHINIST.

For Sale—Patent on clutch; will not slip; wear taken up automatically; simple, light and strong. Address John Schneider, 126 Beach St., Bridgeport, Conn.

For Sale—Machine shop and foundry well equipped, successfully running under lease in best town in eastern Oregon; a rare bargain, $6000 cash, balance time. Box 679, AM. M.

For Sale, second-hand, one 12x24 Harris-Corliss engine and one 30-horsepower James Leffel & Co. high-speed engine; both in prime condition, and may be seen in operation; delivery December 1. Box 645, AMER. MACH.

For Sale—Modern new steel brick lined shop and tools, four years in operation; new tools, electric crane, gas engine and motor drive; running day and night since January; owners will retain part interest and give management to right party; located in Central West. Box 677, AMERICAN MACHINIST.

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Arbor Presses

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Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

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Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
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Union Mfg. Co., New Britain, Conn.
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American Spiral Pipe Works, Chicago, Ill.

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Lyon Metallic Mfg. Co., Aurora, Ill.

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Underwood Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
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Cling-Surface Mfg. Co., Buffalo, N. Y.
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Shultz Belting Co., St. Louis, Mo.
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Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

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Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

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American Spiral Pipe Works, Chicago, Ill.

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General Electric Co., New York.
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McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, O.
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Newton Machine Tool Wks., Inc., Phila., Pa.
New Haven Mfg. Co., New Haven, Conn.
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Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolts and Nuts

Electric Welding Products Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
McGraw-Hill Book Co., New York.
International Text Book Co., Scranton, Pa.
Sames, Chas. M., Jersey City, N. J.